

ACRP

REPORT 89

**AIRPORT
COOPERATIVE
RESEARCH
PROGRAM**

Sponsored by
the Federal
Aviation
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Guidelines for Airport Sound Insulation Programs



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ACRP REPORT 89

Guidelines for Airport Sound Insulation Programs

Michael K. Payne
Rita A. Smith
THE JONES PAYNE GROUP, INC.
Boston, MA

Deborah Murphy Lagos
URS GROUP
Tampa, FL

Jack Freytag
Freytag & Associates, LLC
Newport Beach, CA

Mark Culverson
LARSON MANUFACTURING
Lakeville, MN

Jean Lesicka
CSDA ARCHITECTS
Phoenix, AZ

James Leana
S&L SPECIALTY CONTRACTING
Syracuse, NY

Robert R. Smith
HVAC CONSULTANT
Virginia Beach, VA

A. Vernon Woodworth
R.W. SULLIVAN ENGINEERING
Boston, MA

Robert Valerio
HILL INTERNATIONAL, INC.
San Ramon, CA

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AIRPORT COOPERATIVE RESEARCH PROGRAM

Airports are vital national resources. They serve a key role in transportation of people and goods and in regional, national, and international commerce. They are where the nation's aviation system connects with other modes of transportation and where federal responsibility for managing and regulating air traffic operations intersects with the role of state and local governments that own and operate most airports. Research is necessary to solve common operating problems, to adapt appropriate new technologies from other industries, and to introduce innovations into the airport industry. The Airport Cooperative Research Program (ACRP) serves as one of the principal means by which the airport industry can develop innovative near-term solutions to meet demands placed on it.

The need for ACRP was identified in *TRB Special Report 272: Airport Research Needs: Cooperative Solutions* in 2003, based on a study sponsored by the Federal Aviation Administration (FAA). The ACRP carries out applied research on problems that are shared by airport operating agencies and are not being adequately addressed by existing federal research programs. It is modeled after the successful National Cooperative Highway Research Program and Transit Cooperative Research Program. The ACRP undertakes research and other technical activities in a variety of airport subject areas, including design, construction, maintenance, operations, safety, security, policy, planning, human resources, and administration. The ACRP provides a forum where airport operators can cooperatively address common operational problems.

The ACRP was authorized in December 2003 as part of the Vision 100-Century of Aviation Reauthorization Act. The primary participants in the ACRP are (1) an independent governing board, the ACRP Oversight Committee (AOC), appointed by the Secretary of the U.S. Department of Transportation with representation from airport operating agencies, other stakeholders, and relevant industry organizations such as the Airports Council International-North America (ACI-NA), the American Association of Airport Executives (AAAE), the National Association of State Aviation Officials (NASAO), Airlines for America (A4A), and the Airport Consultants Council (ACC) as vital links to the airport community; (2) the TRB as program manager and secretariat for the governing board; and (3) the FAA as program sponsor. In October 2005, the FAA executed a contract with the National Academies formally initiating the program.

The ACRP benefits from the cooperation and participation of airport professionals, air carriers, shippers, state and local government officials, equipment and service suppliers, other airport users, and research organizations. Each of these participants has different interests and responsibilities, and each is an integral part of this cooperative research effort.

Research problem statements for the ACRP are solicited periodically but may be submitted to the TRB by anyone at any time. It is the responsibility of the AOC to formulate the research program by identifying the highest priority projects and defining funding levels and expected products.

Once selected, each ACRP project is assigned to an expert panel, appointed by the TRB. Panels include experienced practitioners and research specialists; heavy emphasis is placed on including airport professionals, the intended users of the research products. The panels prepare project statements (requests for proposals), select contractors, and provide technical guidance and counsel throughout the life of the project. The process for developing research problem statements and selecting research agencies has been used by TRB in managing cooperative research programs since 1962. As in other TRB activities, ACRP project panels serve voluntarily without compensation.

Primary emphasis is placed on disseminating ACRP results to the intended end-users of the research: airport operating agencies, service providers, and suppliers. The ACRP produces a series of research reports for use by airport operators, local agencies, the FAA, and other interested parties, and industry associations may arrange for workshops, training aids, field visits, and other activities to ensure that results are implemented by airport-industry practitioners.

ACRP REPORT 89

Project 02-24

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The members of the technical panel selected to monitor this project and to review this report were chosen for their special competencies and with regard for appropriate balance. The report was reviewed by the technical panel and accepted for publication according to procedures established and overseen by the Transportation Research Board and approved by the Governing Board of the National Research Council.

The opinions and conclusions expressed or implied in this report are those of the researchers who performed the research and are not necessarily those of the Transportation Research Board, the National Research Council, or the program sponsors.

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CRP STAFF FOR ACRP REPORT 89

Christopher W. Jenks, *Director, Cooperative Research Programs*
Crawford F. Jencks, *Deputy Director, Cooperative Research Programs*
Michael R. Salamone, *ACRP Manager*
Theresia H. Schatz, *Senior Program Officer*
Terri Baker, *Senior Program Assistant*
Eileen P. Delaney, *Director of Publications*
Doug English, *Editor*

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Field of Environment

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Carla Kell-Smith, *C. Kell-Smith & Associates, Inc., San Bruno, CA*
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FOREWORD

By **Theresia H. Schatz**

Staff Officer

Transportation Research Board

ACRP Report 89: Guidelines for Airport Sound Insulation Programs provides updated guidelines for sound insulation of residential and other noise-sensitive buildings for potential use by airport and non-airport sponsors to develop and effectively manage their aircraft noise insulation projects. Noise-sensitive buildings are defined as “residences (single family and multi-family), schools, hospitals, churches, and other non-compatible structures identified in the sponsor’s NCP and approved by the FAA as a project in the NCP,” by the *AIP Handbook*, FAA Order 5100.38C, paragraph 812.A.

As the guidelines were being finalized, Program Guidance Letter (PGL) 12-09, “AIP Eligibility and Justification Requirements for Noise Insulation Projects,” was released by the FAA on August 17, 2012. The PGL replaced existing guidance on the implementation of AIP-funded noise insulation projects as had previously been provided per Section 812 of the *AIP Handbook*, FAA Order 5100-38C. At the time that the *ACRP Report 89* guidelines were finalized, there were outstanding questions regarding the PGL. These outstanding questions and related issues are discussed throughout the text with advice to users to contact their ADO project manager regarding any further guidance or information that has been provided since the publication of these guidelines.

This research will be very helpful to improve current practices and ensure compliant airport sound insulation programs. The research significantly expands information available on best practices and current standards and requirements for sound insulation of homes as well as for other eligible noise-sensitive buildings. The guidelines are a very useful tool for airport staff, consultants, and FAA offices to use with the AIP guidance provided in the *AIP Handbook* as updated by PGLs from time to time.

To assist sponsor-approved noise programs, FAA published AC 150/5000-9A in July 1993 that announced the availability of the *Guidelines for the Sound Insulation of Residences Exposed to Aircraft Operations* (the guidelines). The guidelines themselves were published in 1992 for military and FAA airport programs to serve as a project management handbook for studying, initiating, and implementing sound insulation measures developed under airport noise compatibility programs. The guidelines were updated in 2005 by the U.S. Navy for application at military airports. The Navy updated the guidelines to meet their current program objectives and to reflect current building codes and insulation product specifications. This research has developed updated guidance for sponsors to effectively manage noise insulation programs of eligible structures in conformance with FAA Noise Compatibility Program (NCP) and Airport Improvement Program (AIP) funding requirements.

This research was conducted under ACRP Project 02-24 by the Jones Payne Group in association with URS Group, Freytag & Associates, Larson Manufacturing, CSDA Archi-

fects, S&L Specialty Contracting, Robert R. Smith, R.W. Sullivan Engineering, and Hill International, Inc.

A separate contractor's final report, which provides background to the research conducted in support of the guidebook, has been posted on the ACRP Project 02-24 web page at <http://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=2795>.

AUTHOR ACKNOWLEDGMENTS

The proposal submitted recognized that the experience required to update the guidelines would not reside in a single individual or firm. As such, the Jones Payne Group (JPG) proposed that it would be necessary to assemble a research team of individuals who are experts in key areas of sound insulation programs. JPG assembled a team of individuals from seven firms who have expertise in their assigned areas of inquiry as well as a broad perspective and experience in sound insulation programs. Team members are:

Michael K. Payne, AIA – The Jones Payne Group	Principal Investigator and Historic Treatment Design
Rita A. Smith, AIA – The Jones Payne Group	Project Manager and Architectural Treatment Design
Jack Freytag, PE, INCE – Freytag & Associates	Acoustical Engineering
Deborah Murphy Lagos, INCE – URS Group	Program Development and Funding
Mark Culverson – Larson Manufacturing	Product Development
Robert Valerio – CSDA Architects, Hill International	Project Reporting/Closeout
Jean Lesicka – CSDA Architects	Community Outreach
James Leana, PE – S&L Specialty Contracting	Construction Contracting and Cost Estimating
Robert R. Smith – HVAC Consultant	HVAC/Ventilation
A. Vernon Woodworth, AIA, LEED AP	Sustainability and Energy Efficiency

We were assisted in our efforts by professional colleagues providing peer review of certain sections of the report. We thank Alan Hass of Landrum & Brown and Tariq Hussein of PBS Engineers for their assistance. We also thank our editor, Donna L. Cook, for her expertise. The team would like to acknowledge and thank the many consultant and airport colleagues who shared their time participating in the survey conducted as part of the research.

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Note: Many of the photographs, figures, and tables in this report have been converted from color to grayscale for printing. The electronic version of the report (posted on the Web at www.trb.org) retains the color versions.

Introduction

1.1 Sound Insulation History

Current operational trends show that environmental impacts . . . will be the primary constraints on the capacity and flexibility of the Next Gen unless these impacts are managed and mitigated. . . . Airports will need to escalate their efforts to address the environmental concerns of their neighboring communities. . . . Noise has been and will continue to be a primary area of concern.

— Joint Planning and Development Office, “Concept of Operations for Implementing the Next Generation Air Transportation System,” 2007

Those who anticipate a complete Federal solution to the aircraft noise problem misunderstand the need for federal, local and private interaction. . . . The primary obligation to address the airport noise problem always has been and remains a local responsibility.

— Introduction to the FAA’s 1976 Aviation Noise Abatement Policy

While the federal government has no jurisdiction over local or state land use decisions (i.e., zoning), the FAA can and does influence compatible land use planning. Under the Aviation Safety and Noise Abatement Act of 1979 (ASNA), the FAA was directed to define compatible and non-compatible land uses in and around the nation’s airports.¹ Toward this end, in 1985, Part 150 of the Federal Aviation Regulations was adopted and established.² The Part 150 process created:

1. A uniform system of assessing noise impacts around individual airports. These impacts are expressed in noise exposure maps (NEMs).
2. Land use compatibility criteria and measures necessary to enhance compatibility [i.e., a noise compatibility program (NCP)].

As part of an NCP, measures to achieve compatibility are proposed and typically characterized as either:

1. Noise abatement measures, such as aircraft flight procedures that reduce noise or redistribute it to less-populated areas, or
2. Land use measures, such as property acquisition or sound insulation of noise-sensitive properties.

After the airport authority submits an NCP, the FAA will respond with a Record of Approval (ROA) stating which measures are approved or not approved and are eligible or ineligible for funding under its Airport Improvement Program (AIP). Since 1992, approximately \$1.9 billion in AIP funding has been provided to sound insulation programs nationally. Additionally, \$1.1 billion in passenger facility charge (PFC) funds has been provided since 1992. This combined investment

¹ Aviation Safety and Noise Abatement Act of 1979, H.R. 2440, 96th Cong, <http://www.govtrack.us/congress/bills/96/hr2440>.

² Docket No. 18691, 49 FR 49268, December 18, 1984.

of more than \$3 billion for sound insulation is an indication of the importance of achieving compatibility between communities and airport operations.³ Without such efforts, aircraft noise will continue to be the primary constraint on the improvement of the nation's aviation infrastructure.

Mitigating the impact of aircraft noise on communities is known by a variety of terms, including noise insulation, noise attenuation, soundproofing, sound insulation, acoustical treatment, sound mitigation, and noise mitigation. Individual airports often give their programs unique names incorporating some of these descriptors. To avoid confusion, these guidelines will use the term *sound insulation* throughout.

1.1.1 The Airport Improvement Program

The AIP is authorized by Chapter 471 of Title 49 of the United States Code (USC). Previously, the AIP was authorized by the Airport and Airway Improvement Act of 1982 (P.L. 97-248, as amended). The AIP's broad objective is to assist in the development of a nationwide system of public-use airports adequate to meet the current needs and projected growth of civil aviation. The act provides funding for airport planning and development projects at airports included in the National Plan of Integrated Airport Systems (NPIAS) and authorizes funds for noise compatibility planning and implementation.

1.1.2 FAA Order 5100.38C, the *Airport Improvement Program Handbook*

The *Airport Improvement Program Handbook* (also referred to throughout as the *AIP Handbook*) provides FAA staff with guidance about the administration of the AIP. It sets forth policy and procedures to be used in the administration of the AIP. *AIP Handbook* Chapter 8, Noise Compatibility Projects, and its Section 2, Noise Compatibility Projects, focus most directly on sound insulation programs.

In the interim between revisions of the handbook, additional information and guidance is provided to users through a variety of FAA publications such as Program Guidance Letters (PGLs), Advisory Circulars (ACs), and FAA directive orders. See the bibliography of publications that are relevant to sound insulation at the end of this document.

The *Guidelines for the Sound Insulation of Residences Exposed to Aircraft Operations* is a prime example of a technical report the FAA promoted through AC 1500 5000-9A. The guidelines provide further information to sponsors and others who are involved in the management and implementation of sound insulation programs.

1.1.3 FAA Program Guidance Letter 12-09

The FAA issued PGL 12-09 to address confusion and ambiguity in the application of the two-step requirement for AIP eligibility for residential and other sound insulation projects.⁴ The *AIP Handbook* interprets Title 14 Code of Federal Regulations (CFR) Part 150 as requiring that structures be located in the existing or forecast yearly day-night average sound level (DNL) 65-dB noise contour and that noise insulation projects be designed to achieve interior noise levels of DNL 45 dB to qualify for federal funding.⁵

³Jawad Rachimi and Joanna Norris, "A Synergistic Green Approach to Conducting Federal Aviation Administration (FAA) and Department of Energy (DOE) Residential Retrofit Programs," Wyle Laboratories, July 25, 2008.

⁴U.S. DOT, FAA, PGL 12-09, August 17, 2012.

⁵U.S. DOT, FAA, PGL 12-09, August 17, 2012, p. 1.

Attachment 1 to the PGL replaces, in its entirety, Paragraph 812, Noise Insulation Projects, of FAA Order 5100.38C, the *AIP Handbook*, effective as of the date of the PGL. Replacement Paragraph 812 describes general requirements for AIP funding, specific eligibility and justification requirements and limitations, and special circumstances.⁶

Attachment 2 to the PGL is entitled “Handling Noise Insulation Programs That Are Currently Underway.” It establishes a transition period (fiscal years 2012 through 2014) during which the FAA will allow sponsors to complete the sound insulation of structures as planned, provided that all sound insulation projects undertaken during this time meet all required federal contract provisions (e.g., Buy American). Any sound insulation project that is started during the transition period must be completed prior to September 30, 2015. Projects for which construction is ongoing after September 30, 2015, must fully meet the AIP requirements, including experiencing pre-insulation interior noise levels of DNL 45 dB or greater.⁷

PGL 12-09 has generated questions from airport sponsors and other interested parties. These are discussed throughout the document with a brief summary of the issue. **Users are advised to consult with their Airport District Office (ADO) or regional office to determine up-to-date guidelines on these issues.**

Additional information regarding the PGL was issued as follows:

1. November 7, 2012: Revised memorandum regarding the PGL issued by the FAA as a Record of Changes to remove “AIP” from title of the PGL; three other corrections noted.⁸
2. November 9, 2012: Additional information regarding the PGL posted to the FAA’s website in the form of nine frequently asked questions (FAQs).⁹

These updated guidelines reflect information provided by the FAA inclusive of the PGL and these two items. Users can access the full text of PGL 12-09 and related documents on the FAA website at http://www.faa.gov/airports/aip/guidance_letters. Users of the guidelines should consult with the FAA for any information published subsequently.

1.2 The Guidelines: Previous Versions

There are two previous versions of the guidelines, both authored by Wyle Laboratories. The first was written in 1989 at the behest of the Naval Facilities Engineering Command and the FAA’s Office of Environment and Energy and Office of Airport Planning and Programming.¹⁰ Wyle Laboratories was charged with creating “a report containing guidelines for the sound insulation of residences exposed to aircraft operations. The report provides a project management handbook for studying, initiating, and implementing residential sound insulation programs in neighborhoods around military and civilian airports.”¹¹

In October 1992, in the interest of information exchange, the U.S. Department of Transportation (U.S. DOT) sponsored the dissemination of the document. The document (Report

⁶U.S. DOT, FAA, PGL 12-09, August 17, 2012, Attachment 1, as amended on November 7, 2012.

⁷U.S. DOT, FAA, PGL 12-09, August 17, 2012, Attachment 2.

⁸U.S. DOT, FAA, PGL 12-09, August 17, 2012, http://www.faa.gov/airports/aip/guidance_letters/media/pgl_12_09_NoiseInsulation.pdf.

⁹U.S. DOT, FAA, PGL 12-09, August 17, 2012, FAQ, http://www.faa.gov/airports/aip/guidance_letters/media/pgl_12_09_NoiseInsulationFAQs.pdf.

¹⁰Wyle Research, Report WR 89-7, *Guidelines for the Sound Insulation of Residences Exposed to Aircraft Operations*, prepared for Naval Facilities Engineering Command and Federal Aviation Administration, November 1989.

¹¹U.S. DOT, FAA, AC 150/5000-9A, Announcement of Availability – Report No. DOT/FAA/PP/92-5, *Guidelines for the Sound Insulation of Residences Exposed to Aircraft Operations*, July 2, 1993, §2.

No. DOT/FAA/PP-92-5) was made available for purchase from the National Technical Information Service.¹² In July 1993, the FAA issued AC 150/5000-9A announcing the availability of Report No. DOT/FAA/PP/92-5, *Guidelines for the Sound Insulation of Residences Exposed to Aircraft Operations*.¹³ This document refers to those guidelines as the “1992 guidelines.”

Note: The FAA underscored the continued relevance of the 1992 guidelines in PGL 12-09, stating: “In 1992, FAA adopted guidance on testing frequency, sampling, and other statistical measures that can be applied to a neighborhood to estimate the interior noise levels in the residences that are in the 65 dB contour.” The footnote for this statement cites the October 1992 guidelines as the “adopted guidance.”¹⁴ A second updated version of the guidelines was created for the U.S. Navy in 2005 and expanded the guidelines to provide information on how to build new sound-insulated residential structures versus sound insulating existing structures. A computer program provided with the updated guidelines made it possible for a nontechnical person to determine acoustical performance specifications for new construction based on input of basic construction information. Topics covered in these versions of the guidelines included:

- Basic concepts of noise and acoustics,
- Noise reduction requirements,
- Sound insulating new and existing houses, and
- Costs and code issues.

Both documents are essentially technical how-to descriptions of designing acoustical treatments for existing and new residential structures. Both documents were sole-sourced documents commissioned by the U.S. Navy for the Navy’s specific use but subsequently endorsed by the FAA for AIP programs. As such, they were not intended to address the full range of issues typically encountered in AIP sound insulation programs (SIPs). The modification tables in Chapter 3 of the 1992 version and Table 3-2, Modifications for Existing Rooms, in the 2005 version display a methodology for codifying acoustical treatments within given circumstances. This methodology can be reviewed with a program’s acoustical consultant for its adaptability to specific AIP programs.

1.3 ACRP Project 02-24: Updating the Guidelines

Per the request for proposals published by ACRP on February 24, 2010, the intent of ACRP Project 02-24 is to:

develop updated guidelines for sound insulation of residential and other noise sensitive buildings for potential use by airport and non-airport sponsors to develop and effectively manage their aircraft noise insulation projects. Noise sensitive buildings are defined as “residences (single family and multi-family), schools, hospitals, churches, and other noncompatible structures identified in the sponsor’s NCP and approved by the FAA as a project in the NCP,” as defined in AIP Handbook FAA Order 5100.38C Chapter 8, Paragraph 812.A.

To accomplish these goals, the researchers developed an approach predicated on two core concepts.

1. Build on the two previous versions by maintaining that which is useful and relevant while updating and expanding the guidelines in key areas not covered in previous versions, and
2. Assemble a research team from various consultant sources rather than relying on the experience of a single firm or entity.

¹² U.S. DOT, FAA, Report No. DOT/FAA/PP-92-5, *Guidelines for the Sound Insulation of Residences Exposed to Aircraft Operations*, October 1992.

¹³ U.S. DOT, FAA, AC 150/5000-9A.

¹⁴ U.S. DOT, FAA, PGL 12-09, August 17, 2012, Attachment 1, PGL, p. 1-6, Table 2.

1.3.1 ACRP Project 02-24: Expanding the Guidelines

While the previous versions of the guidelines have much information that is relevant and applicable to AIP-funded sound insulation programs, they are limited given the clientele for whom they were prepared, the range of issues explored, and the dated information regarding costs and codes.

To address these issues, the research team expanded the purview of the guidelines to include:

- Energy performance and sustainability,
- Community outreach,
- Improvements in products,
- Current code and other regulatory requirements, and
- Bidding methodologies and project costs.



CHAPTER 2

Program Development

Following the FAA's issuance of an ROA for a noise compatibility program or Record of Decision (ROD) for an environmental impact statement (EIS), there is generally a period of time before the implementation of the approved SIP begins. During this time, management structures are determined, details of the program are fleshed out, and funding is sought and obtained. Program development is the bridge between the ROA or ROD and the actual implementation of the approved SIP.

2.1 Qualification and Formulation

An NCP, prepared in compliance with 14 CFR Part 150 (Part 150), contains measures the airport operator proposes to implement in order to reduce noncompatible land uses and prevent the introduction of new noncompatible land uses within the area covered by the airport operator's NEMs. Compatibility of land use is attained when flight operations from the airport do not interfere with existing or planned use of adjacent property. In most cases, interference on adjacent land is due to aircraft noise and vibration exposure in noise-sensitive areas.¹ Whether noise interferes with a particular land use depends on the level of noise exposure and the types of activities involved. Residential neighborhoods; educational, health, and religious structures and sites; outdoor recreational sites; and cultural and historic sites may be noise-sensitive areas.² Land use mitigation measures designed to reduce existing noncompatible land uses are referred to as remedial measures. The most commonly used remedial measures are land acquisition and relocation of occupants, sound insulation, easement acquisition, and purchase assurance/sales assurance/transaction assistance. The ROA contains the FAA's approval or disapproval of each recommended measure in the NCP.

An EIS, prepared in compliance with the National Environmental Policy Act of 1969, as amended (NEPA), requires the FAA to consider the environmental effects of proposed federal actions at public-use airports as well as their reasonable alternatives.³ These environmental effects include noise and compatible land use. The potential effects are evaluated and mitigated in a manner similar to Part 150 studies. The ROD summarizes all environmental impacts the EIS discusses and the mitigation measures required. The airport sponsor is generally responsible for carrying out most mitigation measures, including implementation of a sound insulation program.

¹ U.S. DOT, FAA, Order 5190.6B, *FAA Airport Compliance Manual*, September 30, 2009, §20.2(e), pp. 20–25.

² *Ibid.* Appendix Z, pp. 323–324.

³ U.S. DOT, FAA, FAA Order 5050.4B, *National Environmental Policy Act (NEPA) Implementing Instructions for Airport Projects*, April 2006, Chapter 1.

For aviation noise analysis, the FAA has determined that the cumulative noise energy exposure of individuals to noise resulting from aviation activities must be established in terms of DNL, the FAA's primary metric. The FAA recognizes the community noise equivalent level (CNEL) as an alternative metric for California.⁴

2.1.1 Project Eligibility for Funding Assistance Under the Airport Improvement Program

The AIP is a federal grant-in-aid program that represents a major source of funding for airport development and planning. Established with the passage of the Airport and Airway Improvement Act of 1982, the Office of the Law Revision Counsel re-codified the AIP in 1994 as Chapter 471 of Title 49 of the United States Code.⁵

The AIP has been amended several times to address annual authorizations and other program changes. AIP funds originate from the Airport and Airway Trust Fund, which draws support from user fees, fuel taxes, and other similar revenue sources.⁶

To be eligible for funding assistance under the AIP, noise mitigation projects must be:

1. Approved by the FAA in a Part 150 Noise Compatibility Program ROA,⁷
2. Included as a commitment by the FAA in an environmental ROD for an airport capacity enhancement project, even if the airport has not met the requirements of 14 CFR Part 150,⁸ or
3. Qualified under Title 49 USC, Section 47504, Subsection (c)(2)(D) to soundproof a building in the noise impact area surrounding the airport that is used primarily for educational or medical purposes and that the Secretary of Transportation decides is adversely affected by airport noise.⁹ In most situations, a noise-sensitive land use is considered adversely affected if it is exposed to an annualized cumulative aircraft noise level of DNL 65 dB or higher.

Once the eligibility for funding assistance of the sound insulation program is determined, additional eligibility conditions exist for the individual structures that are potentially eligible for inclusion. The interior noise level of the structure must be determined to be greater than DNL 45 dB with the windows closed.¹⁰

Sponsors interested in funding implementation of noise mitigation projects through the AIP should refer to the FAA's website (<http://www.faa.gov/airports/aip/>) for specific instructions. This website contains a wealth of information regarding the AIP. Under the "Guidance and Policy" section of this website there is a link to the *AIP Handbook* (FAA Order 5100.38C) as well as to PGLs. There is also a section that contains regional supplemental guidance. In addition, there are links to all the AIP-related forms, including the application for federal assistance and quarterly performance report.

2.1.2 Project Eligibility for Funding Assistance Under the Passenger Facility Charge Program

Funding eligibility under the PFC program differs from AIP eligibility. As with the AIP, to be eligible for PFC funding, a noise mitigation project must be a noise-sensitive use located in an area

⁴U.S. DOT, FAA, FAA Order 1050.1E, Change 1, Policies and Procedures for Considering Environmental Impacts, March 20, 2006, Appendix A §14.1a, p. A-60.

⁵U.S. DOT, FAA, Central Region Airports Division, *AIP Sponsor Guide*, October 1, 2010, §100, pp. 100–101.

⁶U.S. DOT, FAA, Central Region Airports Division, *AIP Sponsor Guide*, October 1, 2010, §100, pp. 100–101.

⁷Title 49 USC §47504 (c)(1).

⁸Title 49 USC §47504 (c)(2)(E).

⁹Title 49 USC §47504 (c)(2)(D).

¹⁰U.S. DOT, FAA, Program Guidance Letter 12-09, August 17, 2012, Attachment 1, §812 (b)(1), p. 1-1.

adversely affected by noise, and the proposed mitigation must be eligible for approval as a noise compatibility measure under Part 150 if it were so submitted. However, PFC-funded projects do not have to be submitted to the FAA in a Part 150 study and do not have to receive Part 150 approval. This means that an airport does not have to have a 14 CFR Part 150 ROA in order to conduct sound insulation projects using PFC funds.¹¹ Where a project is not in an approved Part 150 study, the FAA requires a sponsor to provide documentation demonstrating that the project will accomplish a noise mitigation purpose that would be eligible for approval under Part 150. The eligibility of the proposed noise project must be supported by noise contours that could be prepared in conjunction with a Part 150 study, environmental document, or other suitable planning analysis.¹²

Sponsors interested in funding implementation of noise mitigation projects through PFCs should refer to the most current version of FAA Order 5500.1, Passenger Facility Charge, for specific instructions. It is available on the FAA's website (http://www.faa.gov/airports/resources/publications/orders/media/PFC_55001.pdf).

2.1.3 Project Sponsorship Requirements

The FAA typically refers to recipients of AIP grants as “sponsors.” A sponsor’s eligibility to receive funds under the AIP program varies per the type of airport and the type of project activity.¹³ Sponsors must be legally, financially, and otherwise able to carry out the assurances and obligations contained in the project application and grant agreement.¹⁴

Eligible sponsors include units of local government having jurisdiction over the project location, airport sponsors, and special-purpose units of local government (e.g., school and hospital districts).¹⁵ The different types of sponsors eligible to receive funds are described in the following.

A. Public Agencies Owning Airports

Public agencies owning public-use airports are eligible to receive grants for sound insulation. A public agency means a state, the District of Columbia, the Commonwealth of Puerto Rico, the Virgin Islands, American Samoa, the government of the Northern Mariana Islands, or Guam, or any agency of them, a municipality or other political subdivision, a tax-supported organization, or an Indian tribe or pueblo.¹⁶

B. Certain Public Agencies Not Owning Airports

Public agencies not owning public-use airports are eligible to receive grants for sound insulation where such projects are for educational or medical buildings within the noise impact area of a public airport or are included within the airport’s Part 150 program as approved by the FAA.¹⁷

C. Certain Private Airport Owners/Operators

Private airport owner/operators are eligible to receive grants for sound insulation. A private airport owner/operator may be an individual, partnership, corporation, or so on that owns a public-use airport used or intended to be used for public purposes, that is a reliever airport or an airport that has at least 2,500 passenger boardings each year, and that receives scheduled passenger aircraft service.¹⁸

¹¹ U.S. DOT, FAA, PGL 12-09, August 17, 2012, §10, p. 3.

¹² U.S. DOT, FAA, FAA Order 5100.38C, *Airport Improvement Program Handbook*, June 28, 2005, §706 (c), p. 125.

¹³ U.S. DOT, FAA, FAA Order 5100.38C, *Airport Improvement Program Handbook*, June 28, 2005, §200 (a), p. 21.

¹⁴ U.S. DOT, FAA, FAA Order 5100.38C, *Airport Improvement Program Handbook*, June 28, 2005, §201 (a), p. 21.

¹⁵ See note 10. Attachment 1, §812 (b)(3), p. 1-3.

¹⁶ See note 12. §206, p. 23.

¹⁷ See note 12. §207 (b)(3), p. 23.

¹⁸ See note 12. §208, pp. 23-24.

D. Co-Sponsors

Any two or more units of local government may co-sponsor a noise compatibility project, provided that such units of local government jointly or severally are eligible sponsors. An airport sponsor may be a co-sponsor on such a project. The FAA encourages co-sponsorship, particularly where it would contribute to more effective compatible land use commitments on the part of the unit of local government having jurisdiction over land use.¹⁹

2.1.4 Items to Consider Prior to Program Start-Up

A. Types and Number of Structures

Potentially eligible structures include buildings used for the following purposes: residential, educational, medical, religious, and other noncompatible uses identified in the sponsor's NCP and approved by the FAA as a project in the NCP. In addition, sound insulation treatments may be provided to buildings near an airport without an approved NCP if the buildings are used for educational or medical purposes and they are demonstrated to be adversely affected by airport noise.²⁰ Unless extenuating circumstances dictate, sound insulation should normally not be considered for noise-sensitive structures (e.g., residences, schools, hospitals, places of worship) within a yearly DNL 75 dB or greater noise contour since these uses are never compatible in these noise contours.²¹

Identifying the type and number of structures that are potentially eligible for participation is a critical task that should be addressed at the earliest opportunity. This task may have been addressed during the Part 150 noise compatibility study (Part 150 study)²² or the environmental impact study,²³ among others. The definition of the type of land use and determination of potential eligibility are critical components of moving forward with sound insulation programs. For example, the definition of a "single-family home" varies across the country. Programs have had difficulty when the definition was not explicit in the NCP description of eligible residences. A duplex or townhouse is defined in many real estate transactions as a single-family attached home, while in other cases it is defined as part of a multifamily residential structure. When the NCP has simply recommended sound insulation for "single-family homes" without defining what is to be considered as one, the FAA has been known to consider these to be multifamily structures and deem them ineligible until an updated NCP is produced that adds additional structure types to the program.

Date of Construction. In order to be potentially eligible for participation, structures must have been built on or before October 1, 1998. Exceptions include situations where the sponsor can demonstrate to the FAA that:

1. No published noise contours existed at that time,²⁴
2. The structure was outside the published noise contours that existed at the time of its construction,²⁵ or
3. The structure constitutes minor development on a vacant lot within an existing residential neighborhood.²⁶

¹⁹ See note 12. §803, p. 132.

²⁰ See note 7. §47504 (c)(2)(D).

²¹ See note 10. Attachment 1, §812 (c)(3), Table 3, p. 1-9.

²² U.S. DOT, FAA, 14 CFR Part 150, Amendment 150-4, Airport Noise Compatibility Planning; Final Rule, September 24, 2004, §A150.101.

²³ See note 4. §14.4i, p. A-63.

²⁴ See note 10. Attachment 1, §812 (c)(1), Table 1, p. 1-4.

²⁵ Federal Register, FR Volume 63, Number 64, p. 16414.

²⁶ Federal Register, FR Volume 63, Number 64, p. 16414.

GIS Mapping and Property Inventory. Geographic information system (GIS) technology provides a means for managing and using data that have been spatially referenced. Generally, the spatial referencing system used in GIS technology is modeled on the earth's surface. GIS technology can be useful for assessing the relationship between aircraft-generated noise levels and land uses, noise-sensitive receptors, and demographics in the airport environs. It is a useful tool for developing base mapping and delineating program boundaries, current land use, jurisdictions, population, housing, noise-sensitive sites, historic buildings/sites, and airport-related easements. With a properly configured GIS database, the results of the analysis will be consistent and repeatable. There are many commercial GIS software packages with various levels of complexity available. As such, sponsors can create and manage GIS mapping with in-house staff or outsource to a GIS consultant.

There are a variety of sources for GIS data. Sources for the land use and noise-sensitive receptor data include organizations such as the local planning department of municipalities, regional planning councils, and statewide GIS data clearinghouses. It is important to obtain data with the highest resolution and accuracy available in order to identify noise-sensitive receptors such as residential neighborhoods; educational, health, religious, cultural, and historic structures and sites; and outdoor recreational sites. Generally, this means using data at the local municipality level. These data are usually more up to date and detailed than data from regional- or state-level sources. Parcel-level data may be available from the local property appraiser's office in which the land use code is included. Parcel-level data represent very high-resolution data and are often updated at least once a year. Population and household information can be estimated at the parcel level, provided that the local municipalities maintain current estimates of people per household and a housing unit count for multifamily parcels.

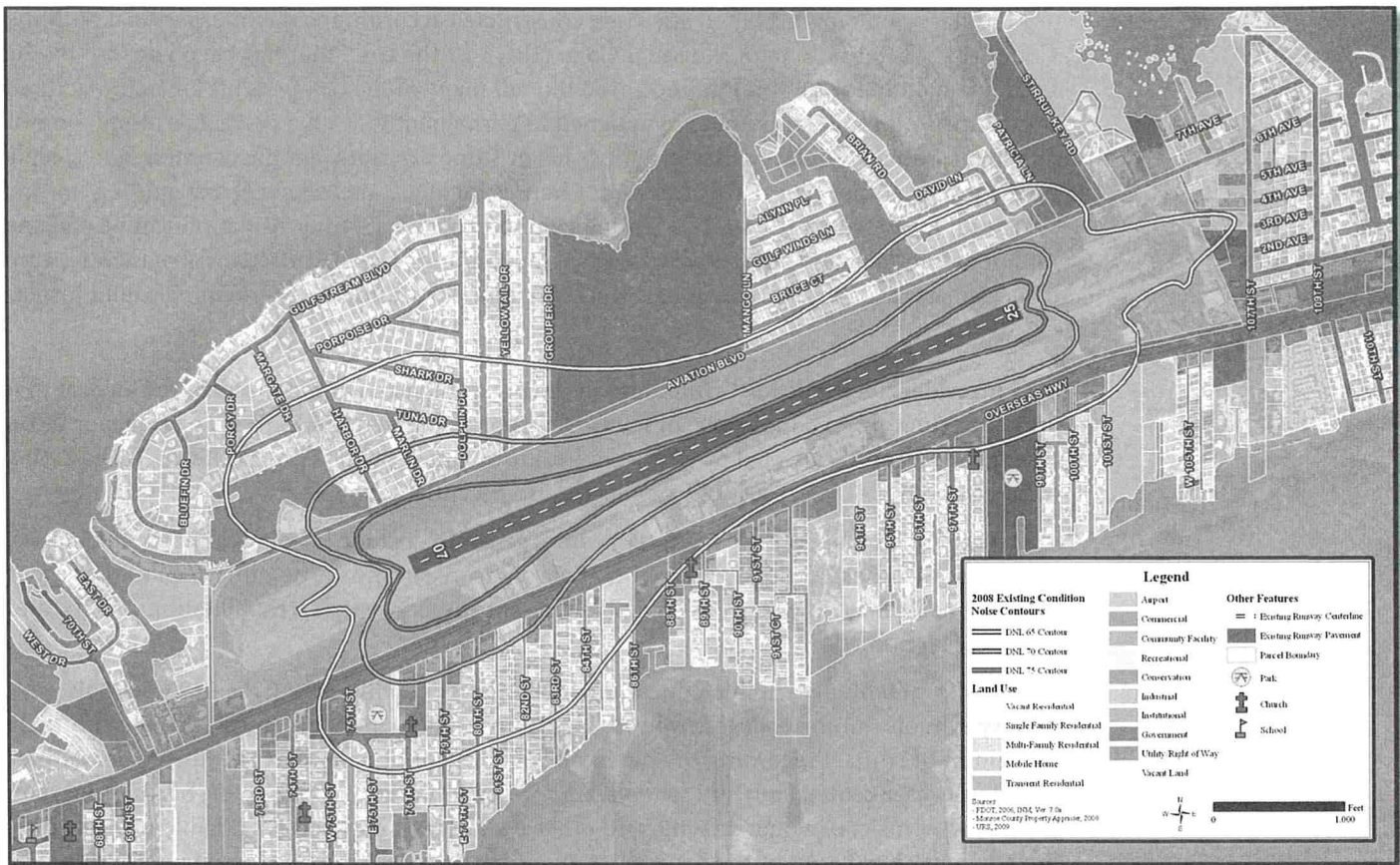
The analytical results of the GIS can be presented both graphically and in tabular form. The most prominent and well-known presentation format for GIS data is as a map graphic, as shown in Figure 2.1. Using this method, the results of GIS analysis can be used to develop the base map of the program area, phases, completed houses, and so on. This method allows results to be visualized along with base map features (roads, rivers, lakes, etc.) as location references. Alternately, the results of the GIS analysis can be presented in tables (population, number of houses, etc.). This presentation allows for a more detailed evaluation of the results. The two methods may be combined to provide both map and table presentations of the results.

Since programs are potentially using data gathered and maintained by others, it is a best practices recommendation to drive, street by street, through the area within the contour and conduct a windshield survey to confirm the data. This is especially important if the Part 150 structure data were generated from aerial photography or other technology that is not as accurate as a municipal GIS database.

Residential Facilities. All residential land uses and related structures in areas where DNL values are 65 dB or greater are generally considered noncompatible.²⁷ Residential facilities potentially eligible for sound insulation generally include single-family and multifamily residences.²⁸ Sponsors must consult with their FAA point of contact regarding the potential eligibility of other types of residential structures, such as rooming and boarding houses, fraternity and sorority houses, residence halls and dormitories, retirement homes, orphanages, convents, monasteries, rectories, hotels and motels, convalescent and nursing homes, nurses' residences, sleeping quarters of fire stations, correctional institutions, other types of membership lodging, group quarters, religious quarters, and transient lodging. The sponsor's point of contact within the FAA organization

²⁷ See note 22. §A150.101.

²⁸ See note 10. Attachment 1, §812 (c)(3), Table 3, p. 1-9.



Graphic courtesy of Florida Keys Marathon Airport and URS Corporation. (Note: color coding can be seen on the PDF available at www.TRB.org.)

Figure 2.1. Example of noise contours superimposed over GIS land use base map.

is typically the FAA program manager or environmental specialist at an ADO or regional office. Contact information is available at http://www.faa.gov/about/office_org/headquarters_offices/arp/regional_offices/.

In addition to residential use, the construction of residential properties may affect eligibility. Standard wood-frame and masonry veneer construction methods are all normal to sound insulation programs. Industry terms for methods beyond traditional construction can be confusing and require differentiation. Houses that are partially or wholly constructed offsite have two major classifications: manufactured homes or modular homes. Manufactured homes (formerly known as mobile homes or trailers) are defined by and constructed according to a code administered by the U.S. Department of Housing and Urban Development (HUD). The HUD code, unlike conventional building codes, requires manufactured homes to be constructed on a permanent chassis.²⁹ Sound insulation is not a viable option for manufactured homes since their design and construction do not lend themselves to effective noise reduction³⁰ and since they are, by design, mobile dwellings, enabling them to be relocated outside of the noise contour area. The walls of a manufactured home would require extensive rebuilding to provide the minimum sound attenuation expected of walls in traditionally constructed homes.

²⁹ "HUD-Manufactured Housing and Standards: General Program Information," United States Department of Housing and Urban Development, accessed November, 2011, http://portal.hud.gov/hudportal/HUD?src=/program_offices/housing/ramh/mhs/faq.

³⁰ See note 10. Attachment 1, §812 (c)(3), Table 3, p. 1-10.

Modular homes in the United States are constructed according to the International Building Code (IBC), International Residential Code (IRC), or the code that has been adopted by the local jurisdiction for site-built homes, even though many of the components are manufactured in a factory. All modular homes are designed to permanently sit on a perimeter foundation or basement. Some modular homes include brick or stone exteriors, granite counters, and steeply pitched roofs. Other types of systems-built houses include panelized wall systems, log homes, structural insulated panels, and insulating concrete forms.³¹ Sound insulation can be a viable option for modular and other types of systems-built homes. Detailed assessment of the structure by design and acoustical professionals will determine the feasibility of providing sound insulation treatments.

Nonresidential Facilities. Buildings in the noise impact area surrounding the airport that are used primarily for educational or medical purposes, and that the Secretary of Transportation decides are adversely affected by airport noise, are qualified under Title 49 USC, Section 47504, Subsection (c)(2)(D).³² Places of worship are also potentially eligible.³³

Types of potentially eligible medical facilities generally include hospitals and nursing homes. Sponsors must consult with their FAA point of contact regarding the potential eligibility of other types of medical facilities such as clinics, outpatient surgery centers, rehabilitation centers, and convalescent homes.

Types of potentially eligible educational facilities generally include primary schools, secondary schools, junior colleges, colleges, and universities. Sponsors must consult with their FAA point of contact regarding the potential eligibility of other types of educational facilities such as day care centers, nursery schools, and professional, vocational, trade, business, barber, beauty, art, music, dancing, driving, and other special training schools. Eligible projects only include noise insulation of the parts of a school that are used for educational instruction. For schools, sound insulation is limited to classrooms and libraries. Facilities within the structure used for incidental instruction such as gymnasiums, cafeterias, and hallways are not eligible.³⁴ Sponsors should consult with their FAA point of contact regarding the potential eligibility of other facilities within the structure for which sound insulation may be justified because of the interference of aircraft noise on speech (e.g., auditoriums, performance spaces).

Types of potentially eligible places of worship generally include churches, synagogues, mosques, temples, kingdom halls, meetinghouses, and chapels. Sponsors must consult with their FAA point of contact regarding which facilities within the structure are eligible (e.g., main worship space, rooms used for religious education, rooms used for child care).

Certain other nonresidential facilities may be eligible for sound insulation. These nonresidential facilities must be identified as noncompatible, be recommended for sound insulation by the airport sponsor in its NCP, and be approved by the FAA. Such proposals should be evaluated carefully, and the determination to noise insulate these structures will be made by the FAA on a case-by-case basis. Sponsors should consult with their FAA point of contact regarding the potential eligibility of other types of nonresidential facilities such as auditoriums, concert halls, libraries, and museums.

Some programs have had to define policies around the issue of ownership for public-use buildings. Because storefront (or leased commercial property) places of worship, schools, and day care facilities are transitory noise-sensitive uses, they normally are not eligible for sound

³¹ See note 29.

³² See note 10. Attachment 1, §812 (b)(1)(C), p. 1-2.

³³ See note 10. Attachment 1, §812 (b)(1), p. 1-1.

³⁴ See note 10. Attachment 1, §812 (c)(3), Table 3, p. 1-9.

insulation. “Storefront” refers to a store or a similar commercial structure not typically used for religious, educational, or child care activities that is used for those purposes on a leasehold basis.

Noncommercial ownership of institutional properties comes in various forms. Some properties are owned in the name of the institution as governed by a board, some are held by a single person such as a pastor or bishop, and some may be owned by a national entity that sponsors the institution. Airport sponsors need to be prepared to accommodate these issues when properties are invited to participate in SIPs. Communication on issues that affect participation, contracts, and signing of legal documents will be more complex than when working with homeowners. Obtaining institutional bylaws, signatory authorizations, legal titles, and other verifications will be needed to ensure that the program is dealing with the appropriately authorized representative who can render decisions.

B. Avigation Easements

Sponsors are encouraged to obtain a noise easement in return for the sound insulation provided by the project, but it is not an AIP requirement.³⁵ Easements are a legal agreement between a grantor (the owner of the property over which the easement right is granted) and a grantee (the holder of the easement rights, usually the airport owner or sponsor).³⁶

A grant under the AIP may not include a requirement that a property owner provide an easement (or other property interest) to the airport sponsor in exchange for sound insulation. FAA policy, however, encourages sponsors to work out such voluntary arrangements locally, exclusive of FAA grant stipulations. However, if the sponsor’s approved Part 150 NCP states that an easement will be obtained from the property owner in exchange for sound insulation, then all participating property owners would be required to convey an easement because the approved mitigation offer includes the easement. This is an issue airports are advised to consider thoroughly within the context of their communities.

In purchase assurance programs, a sponsor may acquire residential property, install sound insulation, and offer the property for resale with an avigation easement.

Also, purchase of an easement may be proposed where sound insulation is not feasible for the particular structure. One example is a structure that needs significant code upgrades in order to qualify for the federally funded sound insulation package, and the homeowners are unable to bring the structure up to code. Another example is a structure that does not qualify for sound insulation because its interior noise level is already below DNL 45 dB.

Reasons It Is Recommended. The FAA encourages that an avigation easement accompany sound insulation to provide notice that the airport has mitigated the noise impact by sound attenuation improvements made to the property. Conveyed easement rights run with the land and apply to any subsequent owners of the encumbered property.³⁷

An easement not only addresses existing incompatible land use concerns, it helps establish the property’s compatibility should the property be sold in the future. An avigation easement ensures that potential buyers are provided with an appropriate disclosure statement that describes airport noise exposure on the property.³⁸ During the settlement process for transfer of property

³⁵ See note 10. Attachment 1, §812 (b)(4), p. 1-3.

³⁶ “Avigation Easements,” Wisconsin Department of Transportation, Wisconsin Bureau of Aeronautics, January 2011, <http://www.dot.wisconsin.gov/library/publications/topic/air/avigation-easements.pdf>.

³⁷ U.S. DOT, FAA, AC 150/5100-17, Change 6, Land Acquisition and Relocation Assistance for Airport Improvement Program (AIP) Assisted Projects, November 7, 2005, §2-15 (b), p. 23.

³⁸ See note 12. §811 (b), p. 139.

ownership, subsequent owners of property with a noise easement should be provided actual notice of the noise impact resulting from airport and aircraft operations.

An easement conveys a defined property interest for a specific purpose. The primary purpose of a noise easement is to establish the property as a compatible land use under the airport's noise compatibility program or project mitigation and help protect the airport against litigation seeking relief from or compensation for airport and aircraft noise.³⁹ However, it may also limit the owner's use of the easement-encumbered property (height restrictions, lighting, etc.) as well as permit right of flight over the encumbered property. An aviation easement that conveys to the airport the right of overflight and associated noise makes the encumbered property compatible with airport operations.

Typical Language. An aviation easement is a property right acquired from a landowner for the use of airspace above a specified height. Aviation easements grant the right of flight, including the right to cause noise and dust inherent in aircraft flight; the right to restrict or prohibit lights, electromagnetic signals, and bird attractants; the right to unobstructed airspace; and the right of entry upon the land to exercise those rights.⁴⁰ The typical language provided in the following text illustrates the concepts of what aviation easements should cover. Sponsors should consult with their legal counsel to determine the exact language appropriate for their circumstances and jurisdictions.

Aviation easement typical language:

GRANTORS do hereby grant, bargain, sell, and convey unto the GRANTEE a perpetual aviation easement and right-of-way for the free and unobstructed flight and passage of aircraft ("aircraft" being defined for the purpose of this instrument as any contrivance now known or hereafter invented, used, or designed for navigation of, or flight in or through, the air) by whomsoever owned or operated, in and through the airspace above, over, and across the surface of the hereinafter described real property, together with the right to cause in said airspace such noise, vibration, odors, vapors, particulates, smoke, dust, or other effects as may be inherent in the operation of aircraft for navigation of or flight or passage in and through said airspace, and for the use of said airspace by aircraft for approaching, landing upon, taking off from, maneuvering about, or operating on the airport. This release is limited to such claims that may arise out of the normal operation of aircraft, and shall not be operative for claims by GRANTORS or those claiming under GRANTORS for any physical or personal injury caused by aircraft crashing into or otherwise coming into direct physical contact with the property or persons located thereon.

Additional provisions regarding lighting may include language such as:

GRANTORS shall not hereafter use, cause or permit to be used, or suffer use of the property in such a manner as to create electrical, electronic, or other interference with radio, radar, microwave, or other similar means of communications between the airport and aircraft, or to make it difficult for the operators of aircraft to distinguish between airport and regularly installed air navigation lights and visual aids and other lights, or so as to result in glare in the eyes of operators of aircraft, or to impair visibility in the vicinity of said airport, or to otherwise endanger the approaching, landing upon, taking off from, maneuvering about, or operating of aircraft on, above, and about said airport.

Additional provisions regarding height restrictions may include language such as:

GRANTORS shall not plant or construct, cause or permit to be planted, grow or construct, or suffer to remain upon the property over which said aviation servitude is situated any bush, shrub, tree, post, fence, building structure, or other obstruction of any kind or nature whatsoever that now extends or that may at any time in the future extend in the airspace above the property to an elevation as prescribed in 49 CFR Part 77, Objects Affecting Navigable Airspace, Subpart C, Obstruction Standards, Subparagraph 77.25, Civil Airport Imaginary Surfaces, as currently in effect and as the same may from time to time be amended, modified, or replaced. In the event that the GRANTORS permit or suffer to

³⁹See note 12. §811 (c), p. 139 and (e), p. 140.

⁴⁰See note 36.

remain upon the aforesaid property over which said avigation servitude is situated any obstruction as defined above, the GRANTEE shall have the right, as its sole option after giving the 5 days prior notice to the GRANTORS, to remove any such obstruction or to mark and light any such obstruction, and to use any and all means necessary to effectuate said right. The GRANTORS hereby grant to the GRANTEE a perpetual servitude for ingress to and egress from the property for the purpose of inspecting and/or measuring to determine the existence of any such obstruction and for the purpose of exercising its above-stated right to remove any such obstruction or to mark and light any such obstruction.

There are many sample avigation easements available. Several samples can be found in Appendix B.

Verifying Property Ownership and Title Status. A title report should be prepared by a qualified title agency. The scope of work should include searching records, identifying the apparent current property owner, and setting forth requirements to clear discovered title defects prior to execution of sound insulation program participation documents. The title report may be based on a limited search of the records rather than a complete examination of title. The title package should include the title report, map, or plat showing the property; a tax sheet showing the tax status, site address, and mailing address for owner; name and address of all mortgage lien holders; and copies of documents that may require action to clear. **Sponsors should consult with their legal counsel to determine the extent of title investigation appropriate for their circumstances and jurisdictions.**

Obtaining Consent from Lien holder(s). Based upon the information obtained from the title report, it may be necessary to contact any mortgage company or other lien holder to obtain their written consent to subordinate their lien to the avigation easement. **Since the process of obtaining consent from lien holders can be a lengthy and sometimes impossible task, sponsors should consult with their legal counsel to determine the benefits of obtaining consent from lien holders versus the risks of proceeding without obtaining consent from lien holders.**

An example of typical language for mortgage lien holders is:

We, the holders of outstanding mortgage(s) on the above property, agree and consent to the granting of this avigation easement and right of flight, and agree and consent that our mortgage shall be subject to and subordinate to the avigation easement and right of flight, and the recording of this avigation easement and right of flight shall have preference and precedence and shall be superior and prior in lien to said mortgage irrespective of the date of the making or recording of said instrument. We, the holders of outstanding mortgage(s) on the above property, further agree that in the event of the foreclosure of said mortgage, or other sale of said property described in said mortgage under judicial or non-judicial proceedings, the same shall be sold subject to said avigation easement.

Recording the Avigation Easement. Once fully executed consent documents have been received from all lien holders and the avigation easement has been fully executed by the property owners and the program sponsor, these documents should be recorded with the clerk of the court in the jurisdiction where the property is located. Once the document has been properly recorded, it will show up in a title search of the property. For homeowner comfort, many programs do not finalize the easement filing until a predefined milestone has been reached in the construction process.

Community Concerns. Most property owners are not as familiar with avigation easements as with utility easements, conservation easements, and right-of-way easements. As a result, property owners often express apprehension when presented with the avigation easement. They are often reluctant to sign the avigation easement, fearing they are surrendering their rights or yielding to the airport's sovereignty. Some common concerns include future airport expansion plans, the potential increase in the number of aircraft operations, and use of bigger or louder airplanes. A common misconception is that the avigation easement eliminates any

recourse if an object falls from an aircraft or an aircraft crashes and injures someone or causes property damage. See Chapter 3 for discussion of managing communication with property owners to deal with such concerns.

2.1.5 Noise Level Requirements

With the issuance of PGL 12-09, the FAA has placed emphasis on the two-step requirement for qualifying structures for AIP-funded sound insulation of being in the DNL 65 dB contour and experiencing a minimum of 45-dB interior noise based on an average of all of the habitable rooms.⁴¹ If the program sponsor is intending to seek AIP funding reimbursement for all treated properties in its noise contour, communication of the possibility that properties may not be eligible if they do not meet both criteria is an important qualifier for the community to understand. From PGL 12-09:

Early communication with all residents that are in the DNL 65 dB contour is important. The sponsor must explain the two-step requirements to residents that are currently in the DNL 65 dB contour.

Further, it is important for the residents to understand that if noise contours change, a neighborhood that was previously identified as potentially noise impacted may no longer be impacted. The sponsor must also explain how the program will be phased. The sponsor must let residents know that final determinations of which residences will be noise insulated will only be made after sampling and testing has been completed. Clearly explaining the noise insulation program process to residents will help prevent unrealistic expectations of residents who may later be found to be outside of the noise impact areas or whose homes already provide sufficient sound insulation.⁴²

Programs will need to determine what their response is going to be for properties that will not be eligible for AIP funding.

A. Noise Contour

Noise compatibility projects usually are located in areas where aircraft noise exposure is significant, as measured by a DNL of 65 dB or greater. This is the level of cumulative aircraft noise exposure below which residential and most other land uses are considered compatible under federal land use compatibility guidelines in 14 CFR Part 150, Appendix A, Table 1.

However, a different standard may be used for 14 CFR Part 150 purposes if the standard has previously been formally adopted by the local jurisdiction that has land use planning authority and is adopted by the airport sponsor. Where a lower local noise standard is adopted outside of the 14 CFR Part 150 process, 49 USC 47141 requires that the land use compatibility plan be developed cooperatively by the airport sponsor and the local jurisdiction. The NEM must depict the locally adopted standard rather than the guidelines contained in 14 CFR Part 150, Appendix A, Table 1.

The NEM and NCP must identify the area as noncompatible and recommend mitigation measures, and the measures proposed for mitigation in that area must meet Part 150 approval criteria.⁴³

B. Interior Noise Level

The purpose of sound insulation is to reduce the impact of airport noise on occupants inside a building. This is accomplished by achieving a noise level reduction (NLR) of exterior to interior noise. The NLR is the difference between the noise measured outside the structure and inside each major and habitable room of the structure.⁴⁴

⁴¹ See note 10. Attachment 1, §812 (c)(1), Table 1, p. 1-3.

⁴² See note 11. §7, pp. 2-3.

⁴³ U.S. DOT, FAA, PGL 05-04, June 3, 2005, §05-4.1.

⁴⁴ U.S. DOT, FAA, Report No. DOT/FAA/PP-92-5, *Guidelines for the Sound Insulation of Residences Exposed to Aircraft Operations*, October 1992, §3.3.1, p. 3-13.

The exterior levels are taken from mapped DNL contours that show DNL in 5-dB increments. In determining the required noise reduction, the higher end of the noise zone range is always used.⁴⁵ The PGL does not directly refer to this methodology except by association with the 1992 guidelines. Program sponsors and consultants should seek advice from their local ADO to confirm noise contour increments to use in calculating interior exposure.

The target noise level for an interior habitable space is DNL 45 dB. Since it takes an improvement of at least 5 dB in NLR to be perceptible to the average person, any sound insulation project should be designed to improve the interior noise environment by at least that amount.⁴⁶

The typical residential building exterior envelope already provides approximately 20-dB noise reduction with windows and doors closed, assuming mechanical ventilation and closed windows year round.⁴⁷ Therefore, many residences within the DNL 65 dB contour may already have acceptable interior noise levels and not be eligible for sound insulation if the average of the interior noise levels in habitable rooms is less than 45 dB.

At lower DNL noise contour levels, the dwelling may already provide this interior DNL 45 dB goal. Per PGL 12-09, if existing construction or the location of the structure within the noise contour results in an average of interior noise levels of less than DNL 45 dB in all habitable rooms, then the structure is not eligible for sound insulation, even though it may be located within the DNL 65 dB noise contour.⁴⁸ To be eligible for AIP-funded sound insulation, the interior noise level prior to sound attenuating modifications must be greater than 45 dB, and the sound insulation project must provide at least a 5-dB benefit as well as reducing interior noise levels to no greater than DNL 45 dB.

Questions have been asked regarding the averaging method, since interior noise levels in a majority of rooms could be greater than DNL 45 dB but a very low interior noise level in one or more of the other rooms could result in an overall average below DNL 45 dB for the structure, thereby making it ineligible for treatment. **Program sponsors and consultants should seek advice from their local ADO if this condition exists in their program.**

Neighborhood Equity. What happens when a residence is in the DNL 65 dB contour but is not experiencing interior noise levels of DNL 45 dB or greater?

The success of a noise compatibility program in a neighborhood relies on the support of the community. This community support may be lost if there is a sense that some residences are being denied sound insulation. When a *few* residences that do not meet the interior noise level requirements are scattered among residences that do meet the interior noise level criteria, there will be confusion among the homeowners as to why one home is being insulated and another is not.⁴⁹

To ensure community support, it may be reasonable to include provisions for neighborhood equity in a sound insulation project. In these cases, the sponsor develops two sets of sound insulation packages. The standard sound insulation package will be prepared for residences that meet the interior noise criteria. A second package (also known as a neighborhood equity package) will be prepared consisting of other improvements such as caulking, weather stripping, installation of storm doors, or ventilation packages for residences that are not experiencing interior noise levels of DNL 45 dB or greater.⁵⁰

⁴⁵ U.S. DOT, FAA, Report No. DOT/FAA/PP-92-5, *Guidelines for the Sound Insulation of Residences Exposed to Aircraft Operations*, October 1992, §3.4.1, p. 3-18.

⁴⁶ See note 10. Attachment 1, §812 (c)(1), Table 1, p. 1-5.

⁴⁷ See note 22. §A150.101, Table 1, Note (1).

⁴⁸ See note 10. Attachment 1, §812 (c)(1), Table 1, p. 1-4.

⁴⁹ See note 10. Attachment 1, §812 (d), Table 4, p. 1-11.

⁵⁰ See note 10. Attachment 1, §812 (d), Table 4, p. 1-11.

The number of houses proposed to receive neighborhood equity packages must be less than 10% of the total number of houses included in a particular phase of the sound insulation program. Regardless of the percentage, no more than 20 residences in a particular phase can be proposed for neighborhood equity packages. If there are more than 10% or 20 residences proposed for neighborhood equity packages within a particular phase, the costs of this work must not be funded with AIP, PFC, or airport revenues. In extremely rare cases, the FAA at the APP-1 level may determine that the program will benefit by providing neighborhood equity packages to more than the 10% or 20-residence limit.⁵¹

If a sponsor proposes the use of secondary packages for neighborhood equity, the sponsor must provide a list to its FAA point of contact that outlines the number of residences that are proposed for sound insulation in the particular phase, identifying the residences that meet the interior noise level criteria and those that do not. The sponsor's report must also provide detailed information about the proposed neighborhood equity package, including cost of the secondary package compared to the cost of a standard sound insulation package.⁵² The FAA must approve the sponsor's neighborhood equity package prior to its implementation.

Use of the standard sound insulation package (the one that is designed for residences experiencing interior noise levels of DNL 45 dB or greater) as the neighborhood equity package is not allowed.⁵³

2.1.6 Best Practice Recommendations: Qualification and Formulation

1. Accurately and specifically identify the type and number of potentially eligible structures prior to launching an SIP. Drive, street by street, through the area within the contour and conduct a windshield survey to confirm the data.
2. Consult with the program's FAA point of contact (typically the FAA program manager or environmental specialist at an ADO or regional office) to verify the specific types of residential and nonresidential structures that are eligible for participation in the SIP.
3. Be prepared to accommodate unique ownership structures for institutional properties invited to participate in SIPs. Issues that affect participation, contracts, and signing of legal documents will be more complex than when working with homeowners. Obtaining institutional bylaws, signatory authorizations, legal titles, and other verifications will be needed to ensure that the program is dealing with the appropriately authorized representative who can render decisions.
4. Consider establishing a program policy requiring property owners to provide an aviation easement (or other property interest) in return for sound insulation, even though the FAA does not require it.
5. Consult with legal counsel to determine the aviation easement language that is appropriate for the program's particular circumstances and jurisdiction(s).

⁵¹ See note 10. Attachment 1, §812 (d), Table 4, p. 1-12.

⁵² See note 10. Attachment 1, §812 (d), Table 4, p. 1-12.

⁵³ See note 10. Attachment 1, §812 (d), Table 4, p. 1-12.

6. Consult with legal counsel to determine the extent of title investigation appropriate prior to execution of SIP participation documents, such as the participation agreement and avigation easement.
7. Consult with legal counsel to determine the benefits of obtaining consent from lien holders versus the risks of proceeding without obtaining consent from lien holders, with regard to execution of avigation easements.
8. Consult with the program's FAA point of contact to verify the eligibility of structures and specific rooms or facilities within those structures.
9. Consult with the program's FAA point of contact to obtain approval for proposed neighborhood equity packages and the residences that will be eligible to receive the neighborhood equity package versus the standard noise insulation package.

2.2 Program Boundaries

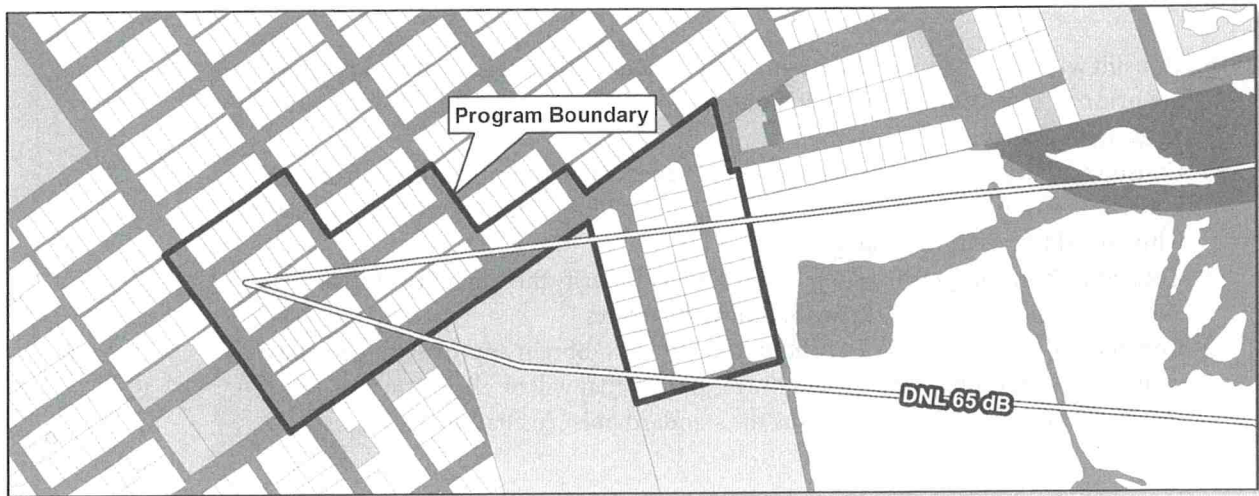
Traditionally, potential eligibility for participation in an FAA-funded sound insulation program has been based on a noise-sensitive structure's location within the DNL 65 dB or greater noise contour or within the FAA-approved program boundary. The decision regarding the extent to which a program boundary can be extended beyond the DNL 65 dB contour for block rounding is an important one that is best resolved during the Part 150 process. This will maximize the opportunity for public input. The program boundary may be expanded beyond the DNL 65 dB contour to include a reasonable additional number of otherwise ineligible parcels contiguous to the project area if necessary to achieve equity in the neighborhood.⁵⁴ No definitive guidance is available to absolutely define a program boundary in every case. Rather, it is expected that professional judgment will be used to ensure that the number of additional houses is reasonable, not excessive. It should be based on identifiable geographic or neighborhood boundaries that are determined on a case-by-case basis for each program's circumstances. An example is provided in Figure 2.2, which shows the boundary being extended to include entire blocks where the noise contour touches at least one residence on the block, and to the residences across the street from those blocks (so that residences facing each other are included, and the boundary is at the rear property line).

2.2.1 Neighborhood Boundary Justification

To ensure equity among homes in the neighborhood affected by the noise mitigation program, the program boundary may be expanded beyond the DNL 65 dB contour line to a logical neighborhood boundary such as the end of a block of houses that may be divided by the contour line, to a highway fronting the neighborhood, or to a stream, open space, or other natural feature defining the immediate pre-project neighborhood limits. Neighborhood or street boundary lines may also help determine what is reasonable, in addition to numbers of properties.⁵⁵ Where necessary and feasible, the program may include a reasonable number of such houses located outside the eligible contour line but identified as part of the neighborhood being soundproofed. The FAA ADO or regional office must concur with the proposed boundaries.

⁵⁴ See note 12. §810 (b), p. 137.

⁵⁵ See note 12. §810 (b), p. 137.



Graphic courtesy of Key West International Airport and URS Corporation.

Figure 2.2. Example of block rounding to establish program boundary.

If the sponsor chooses not to use block rounding, it should inform its FAA point of contact of the method being used to determine the edges of the program. From PGL 12-09:

In determining the reasonable end point for noise insulation projects, the ADO must ensure that the end point is a logical breakpoint (e.g., neighborhood boundary, significant arterial surface street, highway, river, other physical or natural barrier or feature) or whether the end point extends unreasonably beyond a natural break.

In these cases, the sponsor must provide the ADO the proposed end point information. The sponsor must provide the ADO with a list of the specific residences (by address) that will be included in the program. These residences must be noted as “Included due to block rounding.”

The ADO must review and either approve or disapprove including the residences in the noise insulation program.

Note: The airport sponsor may elect not to employ the “block rounding” concept. In such a case it is recommended that the ADO notify APP-1 of the sponsor’s decision not to block round.

Once a residence is approved for block rounding, its interior noise levels will determine whether the residence qualifies for noise insulation or whether the residence is considered under the neighborhood equity provisions.⁵⁶

2.2.2 Part 150 Updates and Changing Contours

ASNA and Part 150 require airport operators to update their NEMs whenever there is a change in DNL of 1.5 dB or greater over noise-sensitive land uses.⁵⁷ This requirement to update NEMs applies to decreases⁵⁸ as well as increases.⁵⁹ If aircraft operations experience significant reductions or the fleet mix changes to substantially quieter aircraft, NEM updates may be needed to reflect size reductions of the airport’s noise contours. This, in turn, can have ramifications for the NCP and the funding eligibility of previously approved NCP measures. FAA funding decisions are based on accurate noise exposure maps.

⁵⁶ U.S. DOT, FAA, PGL 12-09 Attachment 1, §812 (d), Table 4, p. 1-11.

⁵⁷ Title 49 USC §47503 (b).

⁵⁸ See note 22. §150.21 (d)(2).

⁵⁹ See note 22. §150.21 (d)(1).

Absent information to the contrary, NEMs on file with the FAA for less than 5 years may be presumed to be current, and project eligibility may be determined using either the existing or forecast conditions. However, if there is information indicating that the NEMs on file with the FAA do not reflect recent significant changes that have occurred at the airport that would affect the noise contours, the sponsor must submit updated NEMs. Likewise, for NEMs older than 5 years, the sponsor must submit updated NEMs unless it can certify that the existing or forecast-year NEMs on file reflect current conditions at the airport.⁶⁰

A revision of an airport's NCP may be required at the time NEMs are updated. Part 150 states that NCPs should include a provision for revising the program if made necessary by revision of the NEMs.⁶¹ Consequently, if the NEMs are revised and the new maps reveal that land uses previously designated noncompatible are now compatible or vice versa, then NCP elements based on the previous NEMs may no longer be applicable or new elements may be needed. In this case, previously approved NCP measures that are affected by changes in the noise contour need to be updated in order to remain eligible for funding. The FAA will consider whether ongoing mitigation measures that are near completion will remain eligible for purposes of neighborhood equity.

2.2.3 Best Practice Recommendations: Program Boundaries

1. If possible, identify the program boundary during the Part 150 noise compatibility study in order to maximize the opportunity for public input and secure the FAA's concurrence.
2. Consult with the program's FAA point of contact to verify the eligibility of structures with regard to (a) the applicability of block rounding, and (b) what constitutes "a reasonable additional number of otherwise ineligible parcels contiguous to the project area" as they apply to the SIP.
3. Consult with the program's FAA point of contact regarding the timing for updating NEMs and necessity of updating the NCP.
4. Inform the community that contours are subject to change, eligibility is not guaranteed, and houses within current contours may not be eligible for treatment if the contours shrink or change shape.

2.3 Phasing

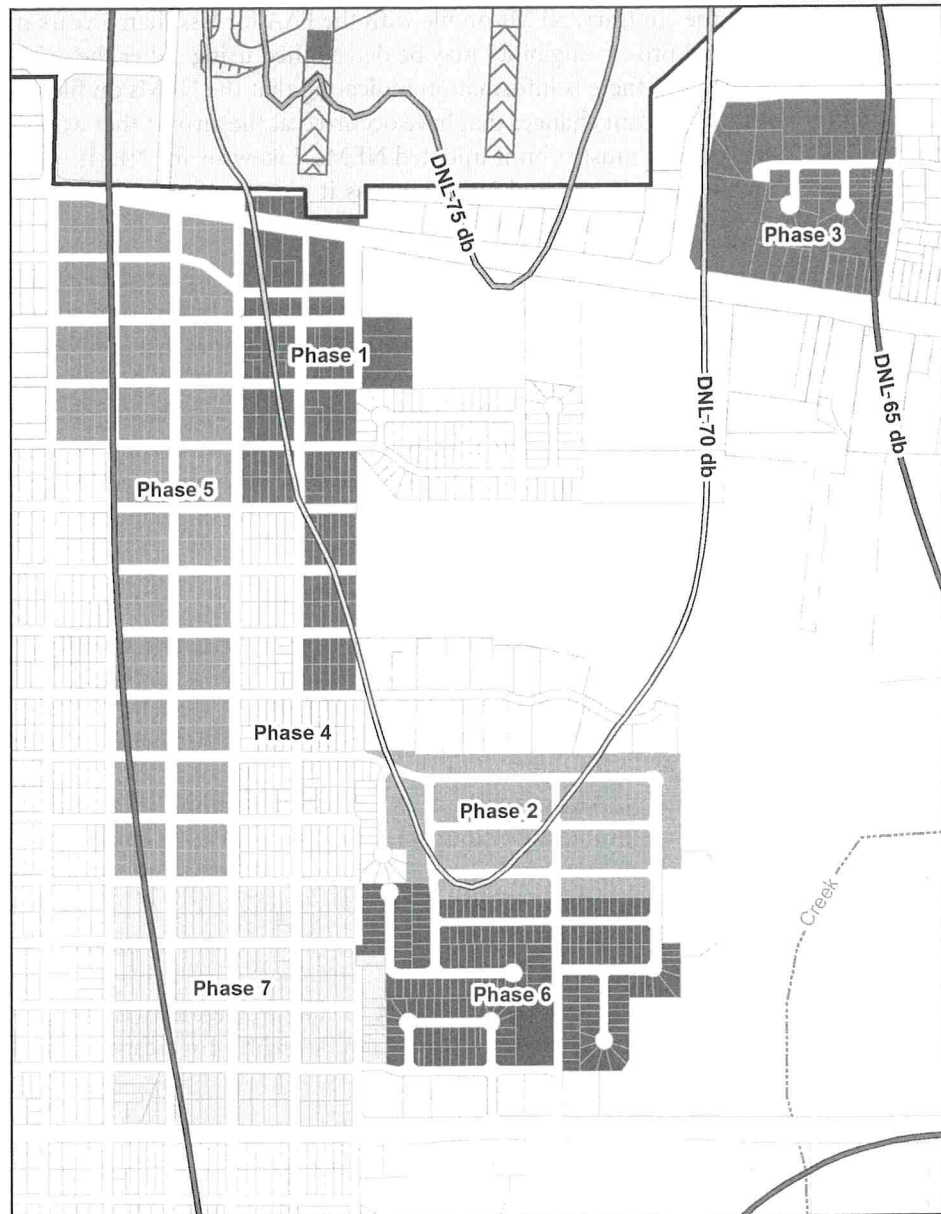
Phasing refers to prioritizing structures for participation in a sound insulation program as well as predetermining the number of structures that will participate at a given time. Prioritization can be based on a number of factors, such as level of noise exposure, geographic location, anticipated funding level, scheduled airport construction, and desired program pace. Keep in mind that it is much more efficient to modify structures that are grouped together geographically. Figure 2.3 illustrates a phasing plan based on geographic proximity.

2.3.1 Prioritizing Participants

Identifying the priority for participation is a critical task that should be addressed at the earliest opportunity. Ideally, this task would have been addressed during the Part 150 process in

⁶⁰ U.S. DOT, FAA, PGL 05-04, June 3, 2005, §05-4.3.

⁶¹ See note 22. §150.23 (e)(9).



Graphic courtesy of Laredo International Airport and URS Corporation.

Figure 2.3. Example of phasing plan based on level of noise exposure and geographic location.

order to maximize the opportunity for public input. The FAA encourages mitigation of structures based on highest noise level exposure, which provides a defensible logic for justifying to the community the sequence and schedule for treating types and groups of eligible structures. Even within the concept of prioritizing according to noise exposure, there are further parameters that may be appropriate. Programs with numerous properties with the same exposure need to decide which of schools, single-family homes, multifamily housing, and so forth are treated first.

Best practices suggest that criteria for further refining prioritization may need to be applied. Programs around the country have used factors such as:

- Treating schools before homes,
- Treating homes before churches,

- Treating single-family homes before multifamily homes,
- Treating owner-occupied homes before tenant-occupied homes,
- Length of ownership (i.e., long-standing owners before newer owners) and
- Hardship situations (e.g., medical, financial).

2.3.2 Conducting a Pilot Phase

Some programs conduct a pilot phase, which generally involves fewer structures but often attempts to include a representative sample of the various construction types found throughout the program area. The pilot phase is, in effect, a complete version of the sound insulation program from start to finish, but on a much smaller scale. This enables sponsors to develop and test their policies and procedures before applying them to the rest of the program. Additionally, data from the pilot phase can be used to develop realistic cost estimates for the rest of the program. Sponsors should note that the pilot phase will most likely be more costly (on a per-unit basis) than the long-range implementation program for a variety of reasons, including that quantity discounts will be available for obtaining doors, windows, and so forth in a larger program. The number of structures chosen for the pilot phase varies depending on several factors, including budgetary constraints and the variety of structure styles in the program area.⁶² A manageable pilot phase might include 20 to 25 homes and one public building, while following phases could each include 50 or more homes and several public buildings.

2.3.3 Best Practice Recommendations: Phasing

1. Consult with the program's FAA point of contact regarding criteria that may be applied to sequence participation in the SIP.
2. Consult with the program's FAA point of contact regarding the need to conduct a pilot phase for the SIP.

2.4 Pre-Implementation Tasks

During the transition period following the FAA's issuance of the ROA for the Part 150 NCP or the ROD for an EIS and the time the actual implementation of the program can begin, there are several issues the sponsor must address and decisions it must make. These are described in the following.

2.4.1 Select Management Strategy

A wide variety of management strategies exist to implement an airport sound insulation program. The sponsor's desired level of day-to-day involvement, control, and responsibility will determine which strategy will best meet its needs. Administration of a sound insulation program generally requires the following expertise:

- Program management.
- Data, GIS, and document management.
- Property owner liaison and community outreach services.
- Contracts, real estate, and contract legal counsel.

⁶² See note 44. §4.1, p. 4-1.

- Architectural design.
- Mechanical heating, ventilation, and air conditioning engineering.
- Electrical engineering.
- Structural engineering.
- Hazardous materials testing and remediation.
- Acoustical engineering.
- Construction management.

Three general management strategies are described in the following, with varying levels of involvement by the sponsoring agency. Greater detail is given to construction contracting and management strategies in Chapter 10.

A. Sponsor Direct Management

While managing the SIP with in-house resources provides the most direct control for the sponsor, it also requires the most sponsor involvement in terms of staff and infrastructure (e.g., office space, equipment, supplies). Personnel requirements may be significantly different than represented by existing staff. This is not unusual since the required functions of an SIP are typically different from those the sponsoring agency normally handles.⁶³ It will most likely involve hiring new staff or transferring them from other departments or programs.

If the sponsoring agency is a government organization, it is unlikely that it will want to take on the architectural and engineering (A/E) design responsibilities along with the associated liability that comes with stamping plans and specifications. Stamping can only be performed by an appropriately licensed design professional. Therefore, these functions will probably be outsourced to professional consultants and coordinated by the in-house program staff. These professional consultants could be selected independently, based on their specific individual qualifications, or, more commonly, could be organized as a design team, led by a registered design professional (i.e., architect or engineer).

A design professional makes three representations when stamping program design and construction documents. First, a design professional's stamp confirms that the document was personally prepared by, or prepared under the direct supervision of, a specific individual, and that that individual has accepted responsibility for the information contained in the stamped document. Second, a design professional's stamp affirms that that individual possesses the training, experience, and skills necessary to perform the scope of work encompassed in the document. By stamping a document, the design professional affirmatively represents that the scope of work is within his or her scope of competence. Finally, a design professional's stamp represents that the document conforms to the standards and requirements of the laws and regulations governing the practice of the applicable design profession. At a minimum, this means that the document satisfies professional standards necessary to protect the public's safety, health, and welfare.

The sponsor may choose to outsource other responsibilities in addition to the A/E tasks. For example, it could select an independent construction manager to provide construction administration, oversight, and on-site inspection services, based on its specific qualifications. With or without additional construction personnel, the professional architects and engineers of the design team will retain functions during construction for inspections, submittal review, and determining if the work meets the standard set by the construction documents.

The most efficient in-house option is implemented by establishing a dedicated program office where the staff assigned to the program are co-located. However, in some cases, it may

⁶³ See note 44. §4.1, pp. 4-1 and 4-3.

be necessary to use staff from across multiple departments and projects, and it may not be feasible to co-locate them in a dedicated program office. This may introduce inefficiencies and complications in coordinating the effort. For small programs or programs with limited or sporadic funding, however, this may be justified and workable. If this option is chosen, it will be important to carefully outline the respective areas of responsibility of each team member and to develop efficient day-to-day lines of communication.

B. Project Manager Strategy

With this management strategy, the sponsoring agency retains a project management (PM) entity to provide services for all aspects of the program except actual construction. While the PM entity contracts with and manages all of the design and service firms needed to deliver the scope of work, the sponsor retains the responsibility to contract construction. This strategy affords maximum flexibility in staffing and better responses to changing program direction and pace. This is because the PM entity is typically able to expand and contract project personnel easier than the sponsor. In addition, this strategy insulates the sponsoring agency from responsibility for many of the house-specific decisions that continually must be made. On the other hand, this option removes most of the day-to-day control from the sponsoring agency, which then acts primarily in an oversight capacity.⁶⁴

With sponsor direct management or with the project manager strategy, design–bid–build is a suitable project delivery method in which the sponsor contracts with separate entities for the design and construction of a project. The sponsor retains a consultant team to design and produce bid documents (plans and specifications) that various general contractors will bid on and use to construct the project. One of the benefits of this option is that the sponsor's consultant is an expert resource who will interface with the contractor to ensure that product and installation quality expectations are met.

C. Turnkey Strategy

The turnkey strategy places all elements necessary for delivery of a sound insulation program under a single entity, typically referred to as the program manager. The turnkey strategy differs from the project manager strategy in that under the turnkey strategy the program manager selects the construction delivery approach and either is the general contractor or contracts directly with the general contractor(s). Chapter 10 describes the various construction delivery approaches. Under the turnkey strategy, a sponsor has a single entity with accountability, namely the program manager. The turnkey strategy is an effective tool for integrating the many facets of sound insulation under a single umbrella, providing a level of continuity for all elements of delivery, including construction, across a multiyear program.

D. Choosing a Strategy

Many factors go into selecting the appropriate management strategy and project delivery method for a sound insulation program. Public sponsors have specific regulations on the types of contracts they are able to employ for professional services or for construction. Hybrids of these strategies and new forms of project delivery methods such as integrated project delivery are being tested in private projects. Many of these strategies are not yet suited to publicly funded projects. When deciding on a management and delivery method, in addition to contracting regulations, program sponsors need to determine how much direct supervision of the program they want and what resources they have to commit to the undertaking.

⁶⁴ See note 44. §4.1, pp. 4-1 and 4-3.

2.4.2 Develop Program Policies

There are several important subjects that the sponsor, in conjunction with the program management team, should address in order to establish program policies. These include:

- How and where should the program boundaries be established?
- What should be the criteria for prioritizing participation?
- Should hardship situations be given consideration?
- If hardship situations are to be considered, what are the criteria for hardships and who will make the decision whether hardship petitions are accepted?
- If the property owner wants to defer participation, at what point and under what circumstances will the owner be able to re-enter the program?
- Are properties owned by employees of the sponsor or consultant team eligible for participation?
- How will major nonconforming building code items or pre-existing deficiencies be addressed?
- How will mixed-use properties be handled (properties with both commercial and residential uses)?
- How will property owner requests for exceptions to recommended treatments be handled?
- How will property owner complaints about design or construction be addressed?

2.4.3 Program Documents

A. Property Owner Notice of Noise Program Implementation

Property owners within the FAA-approved program boundary should be notified of their potential for inclusion in the program via certified mail with a return receipt requested. The notification package should contain the following information:

- A letter introducing the program, explaining the notification process, outlining the requirements for eligibility and participation, and providing contact information in case the property owner has questions.
- A program application.
- A copy of the property owner participation agreement.
- A copy of the aviation easement.
- A pre-addressed envelope for return of the completed application.

B. Property Owner Program Application

The purpose of this document is to determine the property owner's initial interest in the program and to gather and verify contact information about the property owner. It is typically a simple one-page document.

C. Property Owner Participation Agreement

If the NCP includes an FAA-approved measure for sound insulation of privately owned property, Grant Assurance #5 (Grant Assurances, Airport Sponsors, Section C, #5 – Preserving Rights and Powers) requires the sponsor to enter into an agreement with private property owners.⁶⁵ This special condition requires that specific provisions be included in the agreement between the airport operator and the private property owner. These provisions protect the federal investment and the interests of the FAA as well as the airport operator.⁶⁶ The wording of this agreement can

⁶⁵ "Grant Assurances, Airport Sponsors," FAA, April 2012, http://www.faa.gov/airports/aip/grant_assurances/media/airport_sponsor_assurances_2012.pdf, §5 (c), p. 5.

⁶⁶ See note 12. §807 (a), p. 136.

be found in Appendix 7 of FAA Order 5100.38C, *Airport Improvement Program Handbook*.⁶⁷ In addition, the property owner participation agreement should clearly describe the eligibility requirements, with regard to the existing interior noise level of the structure, to qualify for participation in the sound insulation program.

D. Avigation Easement

Avigation easements are discussed in Section 2.1.4(B).

E. Property Owner Pre- and Post-Modification Questionnaires

Once a homeowner is confirmed to participate in the program, the information collected via the pre- and post-modification questionnaires is used to evaluate the property owner's level of satisfaction with the sound insulation program in general and with the modifications. These questionnaires help identify potential issues with the program that can be corrected in future phases. The property owner questionnaires ask the property owner(s) a variety of questions, such as:

- How many years have you lived at this address?
- How many people currently live at this address?
- How much difficulty does aircraft noise cause you, inside your home, in terms of the following noise-sensitive activities? (conversation, falling asleep, being awakened from sleep, concentration, children's sleeping, listening to TV or the radio, talking on the telephone, relaxation)
- Are you annoyed by any community noise sources other than aircraft noise?
- For each primary room in your home, how would you rate the aircraft noise intrusion?
- Have you ever considered moving because of aircraft noise?
- During the past 5 years, have you ever complained to the airport or other officials or individuals about aircraft noise?
- How would you rate the thermal insulation of your home?
- Do you think the modification of your home for sound insulation is a good idea? How would you rate the performance of the consultant team? (for post-modification questionnaire)
- How would you rate the performance of the contractor? (for post-modification questionnaire)

2.4.4 Program Identity

Many airport sound insulation programs establish a unique identity by naming their program or establishing program websites that provide detailed information about their programs. They may also develop a program logo, which is used on all correspondence and collateral materials. Examples of programs that have developed unique identities are:

- San Diego International Airport's Quieter Home Program,
- San Jose International Airport's Acoustical Treatment Program,
- Phoenix Sky Harbor International Airport's Community Noise Reduction Program,
- Reno–Tahoe International Airport's Residential Sound Insulation Program,
- Key West International Airport's Noise Insulation Program,
- Alexandria International Airport's Neighborhood Noise Mitigation Program,
- Baltimore–Washington International Airport's Homeowner Assistance Program,
- San Antonio International Airport's Residential Acoustical Treatment Program,
- Seattle–Tacoma International Airport's Noise Remedy Program, and
- Minneapolis–St. Paul International Airport's Home Mitigation Program.

⁶⁷ See note 12. Appendix 7, §(K), p. 2.

2.4.5 Best Practice Recommendations: Pre-Implementation

1. Carefully evaluate and select a management strategy and project delivery method for implementation of the SIP.
2. Consult with legal counsel to carefully consider program policies that are appropriate and applicable to the unique circumstances of the SIP.
3. Consult with legal counsel to develop program documents that are appropriate and applicable to the unique circumstances of the SIP.
4. Consider establishing a unique identity for the SIP by naming the program and developing a program logo or masthead.
5. Consider developing a program website that provides detailed information about the program.

2.5 Policies and Procedures Manual

The sponsor or consultant team should consider developing step-by-step procedures for implementing the sound insulation program. These procedures can be documented in a policies and procedures manual (PPM).

The manual should clearly identify parcels where sound insulation will be offered. The sound insulation program should be described in an easy-to-follow manner that provides a path for timely implementation. It is helpful for the PPM to provide forms and documents that will be needed in the actual implementation phase of the program.

While approval of the manual is not required, it may be beneficial to provide a copy to the FAA point of contact for review before it is finalized.

A sample table of contents for the manual is provided in Section 2.5.2.

2.5.1 The Need for Written Policies

There are five basic reasons that necessitate writing policies and procedures:⁶⁸

- Operational needs. Policies and procedures ensure that fundamental organizational processes are properly guided by management, that they are performed in a consistent way that meets the organization's needs, and that important related information and data are captured and communicated.
- Risk management. Established policies and procedures are a control needed to manage risk. Procedures define how reasonable measures are built into processes to prevent undesired events, and they describe how the organization will manage and recover from such events should they occur. Similarly, procedures mitigate internal risk, such as when key personnel leave the organization. That risk is diminished to a degree if key organizational knowledge is documented in a procedure, as opposed to important information being stored

⁶⁸ "How Policies and Procedures Can Help Your Organization," Chris Anderson, originally published in 2007 by Bizmanualz, Inc., <http://www.bizmanualz.com/information/2007/11/05/policies-and-procedures-can-help-your-organization.html>.

in a person's head, on a person's computer, or simply jotted down in his or her notebook or journal.

- Continuous improvement. Continuous improvement is one of the most important, yet frequently overlooked, reasons for developing an internal control system of policies and procedures. Clear policies describe operational goals and direction and best practices. Procedures can improve processes by building important internal communication practices.
- Compliance. Complying with laws and regulations should be the most basic function of an organization. Airport sound insulation programs must comply with state and local regulations (e.g., building codes, contractor licensing) as well as federal laws and regulations. Other compliance issues may deal with quality standards such as ISO 9001, ISO 22000, or UL. Well-defined and documented processes, along with records that demonstrate process capability, can demonstrate an effective internal control system compliant with regulations and standards.
- Fairness. The community members in and around the program will want to know that they are receiving the same opportunities as their neighbors. With different types of housing, homeowners can look at treatments received by others and think they are not getting the same thing. When participants have access to a policy manual detailing how the design process identifies what treatments a property will receive, participants will be able to see that they are being treated under a consistent rule set.

The only reason a sponsor or consultant team might choose not to develop a PPM is to avoid limiting its flexibility with regard to making decisions on a case-by-case basis as situations arise. Political and community concerns should be taken into consideration when making the decision not to have a program manual.

2.5.2 Sample Table of Contents

The following is an example of a typical table of contents for a PPM:

1. Introduction
 - 1.1 Statement of Policy
 - 1.2 Statement of Purpose
 - 1.3 Program Goals
2. Program Management
 - 2.1 Summary of Administrative and Implementation Roles and Responsibilities
 - 2.1.1 Federal Aviation Administration
 - 2.1.2 State Department of Transportation, Division of Aeronautics
 - 2.1.3 Local Government Jurisdictions
 - 2.1.4 Sponsoring Agency
 - 2.1.5 Airport
 - 2.1.6 Program Management Team
 - 2.2 Management Team Staffing and Responsibilities
 - 2.2.1 Program Manager
 - 2.2.2 Property Owner Agent
 - 2.2.3 Legal Consultant
 - 2.2.4 Architect
 - 2.2.5 Mechanical/Ventilation Engineer
 - 2.2.6 Hazardous Materials Consultant
 - 2.2.7 Sustainability Consultant
 - 2.2.8 Electrical Engineer
 - 2.2.9 Structural Engineer
 - 2.2.10 Acoustical Engineer
 - 2.2.11 Construction Manager

- 2.3 Summary of Program Process and Typical Timeline
 - 2.3.1 Preliminary Tasks
 - 2.3.2 Property Owner Participation Process
 - 2.3.3 Design Process
 - 2.3.4 Bid Process
 - 2.3.5 Product Procurement
 - 2.3.6 Construction Process
 - 2.3.7 Closeout Process
 - 2.3.8 Typical Timeline
- 2.4 Program Funding
- 2.5 Project Office
- 3. Program Criteria
 - 3.1 Areas of Eligibility
 - 3.2 FAA Requirements
 - 3.3 Potentially Eligible Structures
 - 3.4 Treatment of Historic Structures
 - 3.5 Priority for Participation
 - 3.6 Phasing Plan
- 4. Preliminary Tasks
 - 4.1 Legal Document Development
 - 4.2 Development of Property Owner Orientation Handbook
 - 4.3 Identification of Sponsoring Agency's Bidding Requirements for Construction Contracts
 - 4.4 Identification of Local Building Code Requirements
 - 4.5 Identification of Sponsoring Agency's Contractor Payment Process
- 5. Property Owner Participation Process
 - 5.1 Notification of Potential Eligibility
 - 5.2 Property Owner Orientation Session
 - 5.3 Design Survey Meeting
 - 5.4 Property Owner Premodification Questionnaire
 - 5.5 Pre-Construction Testing
 - 5.5.1 Noise Testing
 - 5.5.2 Environmental Testing
 - 5.5.3 Ventilation Testing
 - 5.6 Design Review Meeting
 - 5.7 Property Owner Option for Termination or Deferral
 - 5.8 Limited Title Search
 - 5.9 Signing of Legal Documents
 - 5.10 Construction Phase
 - 5.11 Post-Construction Testing
 - 5.11.1 Noise Testing
 - 5.11.2 Ventilation Testing
 - 5.12 Property Owner Post-Modification Questionnaire
- 6. Design Process
 - 6.1 Pilot Phase
 - 6.1.1 Establishment of Program Standard Treatments and Protocols
 - 6.1.2 Program Standard Products and Specifications
 - 6.1.3 Program Standard Documentation for Agreements and Bid Documents
 - 6.2 Assessment of Existing Conditions
 - 6.3 Program Sponsor Review Process
 - 6.4 Homeowner Review Process
 - 6.5 Construction Document Development
 - 6.6 Cost Estimating

7. Bid Process
 - 7.1 Bid Package Development
 - 7.2 Bid Advertisement
 - 7.3 Pre-Bid Meeting and Site Tours
 - 7.4 Bid Opening
 - 7.5 Bid Review and Contract Award Recommendation
 - 7.6 Contract Award and Notice to Proceed
8. Product Procurement Process
 - 8.1 Final Measurement Visit
 - 8.2 Review and Approval of Product Submittals and Shop Drawings
 - 8.3 Product Delivery and Inspection
9. Construction Process
 - 9.1 Pre-Construction Meeting
 - 9.2 Notification of Property Owners of Scheduled Construction Dates
 - 9.3 Pre-Construction 48-Hour Walk Through
 - 9.4 Construction Meetings/Visits
 - 9.5 Review and Processing of Requests for Information/Change Orders
 - 9.6 Review and Processing of Contractor Payment Applications
 - 9.7 Daily Inspections
 - 9.8 Substantial Completion Inspections
 - 9.9 Development of Punch List
 - 9.10 Final Inspection
 - 9.11 Delivery of Property Owner Warranty Package
 - 9.12 Property Owner Warranty Requests
10. Closeout Process
 - 10.1 Obtain As-Built Record Drawings from Contractor
 - 10.2 Compile Before-and-After Photos of Each Structure
 - 10.3 Assist Sponsor in Completing FAA Closeout Documentation
 - 10.3.1 Sponsor Certification for Final Acceptance
 - 10.3.2 Final Project Cost Summary
 - 10.3.3 Final Outlay Report
 - 10.3.4 Final Construction Report
 - 10.3.5 Summary of Disadvantaged Business Enterprise (DBE) Use
 - 10.3.6 Standard Form (SF) 425 Financial Report
 - 10.3.7 Acoustical Evaluation and Report
11. Appendices
 - A. Avigation Easement
 - B. Program Application
 - C. Property Owner's Pre- and Post-Modification Questionnaires
 - D. Property Owner Participation Agreement

2.5.3 Best Practice Recommendations: Policies and Procedures Manual

1. Consult with legal counsel to ensure that program policies and procedures are in compliance with applicable laws and regulations.
2. Prepare a written PPM for the SIP, and revise it as needed as the program evolves.

2.6 Program Organization

Depending on the management structure selected from Section 2.4.1, some of the following sections may not apply.

2.6.1 Team Selection

FAA AC 150/5100-14D, Architectural, Engineering, and Planning Consultant Services for Airport Grant Projects, provides guidance for airport sponsors in the selection and employment of architectural and engineering consultants under FAA airport grant programs. Firms competing for engineering, architectural, and other professional services must be selected on their qualifications subject to the negotiation of a fair and reasonable price.⁶⁹

The guidelines contained in this AC are recommended by the FAA to comply with 49 CFR 18.36 when selecting consultants for airport projects funded under federal grant programs. This AC does not apply to airport projects that are fully funded with PFC funds.⁷⁰ Rules for procurement under PFC funds are based on policies set by the state, local jurisdiction, or sponsoring agency. For example, Florida Statute 287.055 (Consultant's Competitive Negotiations Act) requires state government agencies, municipalities or political subdivisions, school boards, and school districts to select a consulting firm based on qualifications rather than on a lowest-bid basis. Sponsors should consult with their legal counsel to verify applicable procurement rules that apply to the selection of consultants in this situation.

2.6.2 Team Composition

Following are typical consultant team project management positions and their appropriate responsibilities:

- Program manager.
- Property owner agent.
- Legal consultant.
- Architect.
- Mechanical/ventilation engineer.
- Hazardous materials consultant.
- Sustainability consultant.
- Electrical engineer.
- Structural engineer.
- Acoustical engineer.
- Construction manager.

A. The Management Team

Program Manager

- Act as client liaison.
- Ensure contract compliance.
- Perform overall program management.
- Manage consultant team.
- Perform data and document management.
- Perform GIS mapping and phase documentation.
- Assist in development of program schedule and tasks.

⁶⁹ See note 12. §908, p. 152.

⁷⁰ U.S. DOT, FAA, AC 150/5100-14D, Architectural, Engineering, and Planning Consultant Services for Airport Grant Projects, September 30, 2005, Preamble, p. 1.

- Assist in development of the program budget.
- Assist in the identification and prioritization of program participants.
- Prepare bid package documents.
- Review legal documents.
- Attend public meetings.
- Conduct weekly consultant team meetings.
- Oversee design and construction of product display area.
- Develop visual presentation of products and construction process for property owner information.
- Oversee bid process.
- Submit monthly status reports to client.
- Assist with preparation of grant closeout report for FAA.

Property Owner Agent

- Assist in the coordination of program activities.
- Assist in the setup of the display area.
- Coordinate activities with eligible participants.
- Perform notification and daily communication with eligible participants.
- Attend public meetings.
- Distribute property owner handbooks.
- Assist in property owner orientation session.
- Coordinate pre-existing inspection with the design team.
- Coordinate pre-existing reports and legal releases.
- Attend the design visit.
- Attend design review meeting.
- Present legal documents to property owners.
- Coordinate pre-bid open house session.
- Communicate with construction management staff.
- Handle all correspondence and questions from property owners.
- Coordinate property owner schedules with team members.
- Maintain parcel file and database information.
- Assist in processing contractor payments.
- Assist with project closeout.
- Attend weekly consultant team meetings.

Legal Consultant

- Prepare legal documents.
- Conduct title certifications.
- Record avigation easement.
- Review legal issues.

B. The Design Team

Architect

- Conduct pre-existing deficiency inspection at each eligible property.
- Prepare pre-existing report and legal release.
- Inspect property owner's severe deficiency corrections, if required.
- Conduct design survey at each eligible property.
- Develop technical construction and bid documents.
- Prepare designs in an electronic format.
- Prepare final scope of work documents.
- Conduct design review meeting with property owners.

- Provide alternative solutions/options to property owners regarding aesthetics/function.
- Provide construction cost estimate for bids.
- Prepare addenda to bids and specifications.
- Attend bid opening.
- Review bids and prepare award recommendation.
- Review design revisions.
- Attend weekly consultant team meetings.
- Assist in contractor training.

Mechanical/Ventilation Engineer

- Conduct design survey to observe and define pre-existing ventilation and mechanical equipment capacities.
- Inspect property for severe deficiency corrections, if required.
- Prepare ventilation, insulation, and mechanical design recommendations.
- Design the addition of heating, cooling, and ductwork.
- Provide mechanical schedules and details for bid specifications.
- Act as resource for answering inquiries and inspecting installation of mechanical work, if necessary.
- Coordinate activities with architect, design technicians, and construction manager.
- Modify ventilation design based on architect/property owner/contractor feedback.
- Inspect contractor installation quality.
- Conduct pre-construction and post-construction ventilation tests in each property.

Hazardous Materials Consultant

- Review project scope for extent of hazardous materials based on design intent and create a testing and sampling protocol.
- In each eligible property, locate, sample, and test all materials thought to contain possible hazardous materials in areas that might be disturbed during construction. Quantify all materials tested as positive for hazardous materials.
- Provide documentation identifying all hazardous materials, nature of the material, detailed location descriptions, and quantities of material to be removed as a part of the abatement process.
- Attend design coordination meetings to assist in coordinating the project construction phasing with hazardous material abatement requirements.
- Provide an estimate for the market value of the abatement work to be completed based on the quantity and locations of materials identified.
- Develop abatement specifications and documents detailing abatement procedures and requirements.
- Provide oversight of abatement work performed at the site while abatement is occurring to ensure compliance with all guidelines and requirements.
- Provide air quality monitoring during the abatement process, including the establishment of baseline air quality levels prior to the start of the abatement process in any given area.
- Provide clearance testing at the completion of construction in each area.
- Provide a comprehensive hazardous materials assessment of the project after completion of the construction process and provide all final documentation required by governing authorities.

Sustainability Consultant

- Coordinate local utility and government rebate/incentive programs.
- Conduct energy audits of structures to be sound insulated.
- Ensure that SIP meets or exceeds local, national, and international energy codes and rating standards.
- Create policies and procedures for products and installations that meet Energy Star performance criteria.

- Be a LEED (Leadership in Energy and Environmental Design) Accredited Professional to ensure LEED certification of projects.
- Identify additional opportunities/strategies for sustainability practices/products.

Electrical Engineer

- Determine the requirement of an electrical panel upgrade.
- Design electrical wiring for fans and mechanical installations.
- Provide electrical schedules and details for bid specifications.
- Be a resource for answering inquiries and inspecting installation of electrical work, if necessary.
- Coordinate activities with architectural manager, design technicians, and construction manager.
- Inspect property owner severe deficiency corrections, if required.

Structural Engineer

- Determine the extent of a structural condition and the effect of the structural condition to the dwelling for participation.
- Determine and document construction suspensions.
- Inspect property owner severe deficiency corrections, if required.

Acoustical Engineer

- Ensure acoustical compliance via pre- and post-construction acoustical testing.
- Assist in participant prioritization.
- Assist in the preparation of program policy and procedures manual.
- Provide acoustical design goals and consult with architect during design process.
- Review and comment on design documents: unit drawings, specifications, and details.
- Review and prepare recommendations on property owner exception requests.
- Assist with materials inspection, and review and comment on change order requests and requests for information (RFIs).
- Participate in new product review.
- Assist in coordinating airport noise monitoring data with SIP needs.
- Prepare final report on acoustical performance of treatments for submission to the FAA.

C. The Construction Team

Note: The tasks designated for the construction manager are often provided by the members of the design team, depending on sponsor preference.

Construction Manager

- Act as liaison with architect.
- Oversee letting of construction bid documents.
- Assist with construction cost estimates for bids.
- Attend bid opening.
- Perform pre- and post-bid consultation with contractor.
- Review contractor bids.
- Issue notice to proceed to general contractor.
- Assist in contractor training.
- Make photographic documentation of each home prior to, during, and after construction.
- Perform daily site visits to each eligible property or property under construction.
- Complete and submit weekly/monthly status reports.
- Review contract request for change orders.
- Approve and process field change orders.
- Review and approve general contractor pay requests.
- Perform inspection punch list prior to final inspection.
- Attend weekly consultant team meetings.
- Ensure contractor disadvantaged business enterprise (DBE) and payroll compliance.

- Perform punch list walk-through inspection for quality and completion of work.
- Perform final inspection.
- Prepare necessary project reporting and closeout paperwork.

2.6.3 Roles and Responsibilities Matrix

The roles and responsibilities matrix (also known as the RACI matrix) is a responsibility assignment matrix system that brings structure and clarity to assigning the roles people play within a team. It is a simple grid system used to clarify individuals' responsibilities and ensure that everything the team needs to do is addressed. Using the RACI system, list every task, milestone, and decision, then clarify who is responsible, who is accountable, and where appropriate, who needs to be consulted or informed.⁷¹

There are a number of variations to the meaning of RACI participation types. Very often the role that is accountable (A) for a task or deliverable may also be responsible (R) for completing it. There is an alternative coding, less widely published, which modifies the application of the R and A codes of the original scheme. The overall methodology remains the same, but this alternative avoids potential confusion of the terms "accountable" and "responsible."⁷²

The outcome of the RACI process is a two-dimensional matrix, with functions or tasks on one axis and participants or roles on the other, as shown in Figure 2.4.⁷³ In this sample matrix, RACI stands for:

Responsible: Those responsible for the performance of the task. There is typically one role with a participation type of "responsible," although others can be delegated to assist in the work required.

Assists: Those who assist in completion of the task.

Consulted: Those whose opinions are sought and with whom there is two-way communication.

Informed: Those who are kept up to date on progress and with whom there is one-way communication.

For parties or entities that should not be involved with a task or responsibility, that square should be left blank.

2.6.4 Best Practice Recommendations: Program Organization

1. If the SIP is using AIP funding, make sure that the program complies with FAA AC 150/5100-14D in the selection and employment of architectural, engineering, and planning consultants.
2. If the SIP is not using AIP funding, make sure that the program complies with any state, local, or sponsoring agency requirements in the selection and employment of architectural, engineering, and planning consultants.
3. Regardless of the management structure selected to implement the SIP, prepare a roles and responsibilities matrix that clearly identifies all functions and tasks and the responsible parties.

⁷¹ What Is the RACI/ARCI Matrix in Project Management? Swapnil Gyani, The Project Management Hut, October 15, 2008, <http://www.pmhut.com/what-is-the-raci-arc-matrix-in-project-management>.

⁷² Responsibility Assignment Matrix, Wikipedia, accessed November 15, 2011, http://en.wikipedia.org/wiki/Responsibility_assignment_matrix.

⁷³ Guidelines for Creating a RACI-ARCI Matrix, Swapnil Gyani, The Project Management Hut, October 15, 2008, <http://www.pmhut.com/guidelines-for-creating-an-raci-arc-matrix>.

Project Task	FAA	Program Sponsor	Program Manager	Property Owner Agent	Legal Counsel	Architect	Mechanical Engineer	Hazardous Materials Consultant	Electrical Engineer	Structural Engineer	Ventilation Engineer	Acoustical Engineer	Construction Engineer	Contractor	Property Owner
Select project team & administer contracts	I	R													
Communicate with Program Sponsor	I	C	R	I	I	I	I	I	I	I	I	I	I	I	I
Identify and prioritize program participants	C	R	A	I											
Notify and maintain contact with eligible participants	I	C	A	R											
Maintain parcel file & database information			A	R	A	C									
Prepare legal documents and conduct title search		C	I	A	R										
Handle all correspondence and questions from Property Owners		I	C	R	A	A									
Conduct pre-existing deficiency and hazardous materials inspection at each eligible property			C	A		R	A	A	A	A	A				
Prepare pre-existing report & legal release		I	I	A	A	R	C		C	C	C				
Prepare hazardous materials assessment report			I	A		C		R							
Record Avigation Easement			I	A	R										I
Conduct pre-construction and post-construction acoustical testing			I	A		C					R				
Conduct pre-construction and post-construction ventilation testing			I	A		C				R					
Conduct design survey to observe and define pre-existing ventilation characteristics			I	A		C				R					
Determine the replacement and/or addition of mechanical equipment			I			C	R			A					
Determine electrical panel upgrade and design wiring for mechanical equipment installation			I			C	A		R						
Determine the extent of a structural condition			I			C				R					
Prepare ventilation, insulation and mechanical design recommendations			I			C	A			R					
Develop abatement specifications and documents detailing abatement procedures and requirements			I			C	A	R							
Conduct new product review			I			A					R				
Conduct design review with property owner			I	A		R									C
Select window and door colors and styles for individual homes			I	A		C									R
Prepare final plans and specifications			I			R	A	A	A	A	A	A			
Prepare bid documents	C	I	R	A	A	A	A	A	A	A	A	A	A		
Review bids and prepare award recommendation	C	I	A			R						A			
Award and execute construction contract	C	R	A		A							I			
Perform specified modifications and install specified products per plans and specifications			I	I								C	R	I	
Perform air quality monitoring during the abatement process			I	A		C		R							
Ensure Contractor DBE and payroll compliance			I		C	A						R	I		
Perform daily site visits in each property under construction			I	A		C						R		I	
Photograph documentation of each home prior to and during construction				A								R			
Review contract RFIs and requests for change orders			I	I		C	C	C	C	C	C	C	R	C	I
Perform punch list walk-thru inspection for quality and completion of work			I	I		C						R	I	I	
Correct punch list items and warranty issues			I	I		C						C	R	I	
Review & approve General Contractor pay requests			I	C		A						R	C		
Perform final inspection			I	A		A						R	C	I	
Provide warranty package to property owner			I	R								C	A	I	
Assist with preparation of grant close-out report for FAA	I	C	R									A			

Figure 2.4. Example of SIP roles and responsibilities matrix.



CHAPTER 3

Community Outreach

Community outreach is the practice of conducting local public awareness activities through targeted community interaction. The community outreach process involves engaging individuals and groups to involve them in planning, delivering, and participating in projects for themselves and the general public. SIPs use community outreach efforts to create program interest, facilitate program participation, and raise program awareness.

A successful sound insulation community outreach campaign consists of six major components:

1. An understanding of the 14 CFR Part 150 noise compatibility study and how it pertains to sound insulation programs.
2. An understanding of the demographics of the target population.
3. The creation of effective collateral materials that communicate appropriate messages to the target population.
4. A detailed communication plan that identifies strategies and activities to deliver program messages to potential participants.
5. A commitment to maintaining high homeowner satisfaction and a plan to gauge participant satisfaction rates.
6. An awareness of the local media and the role it plays in public perception and the dissemination of program information.

This chapter provides a detailed overview of the six major components of a successful SIP community outreach campaign. This chapter also highlights key items discussed in *ACRP Report 15: Aircraft Noise: A Toolkit for Managing Community Expectations*¹ and outlines the differences between community outreach for residential property owners versus nonresidential property owners. This information is important because sound insulation programs are becoming more community outreach intensive as expectations on the part of the public have increased.

3.1 Planning Efforts Prior to SIP

Successful sound insulation programs begin with the development of an accurate and detailed Part 150 study or environmental impact statement, which is conducted by an airport sponsor. A Part 150 study is a plan initiated by airports to develop and recommend actions to help reduce the impact of aircraft noise in neighborhoods surrounding airports. Although airports are not required to conduct Part 150 studies, voluntary participation in the study qualifies airports

¹Jon M. Woodward, *ACRP Report 15: Aircraft Noise: A Toolkit for Managing Community Expectations*, Transportation Research Board of the National Academies, Washington, D.C., 2009.

to receive federal funding to implement FAA-approved airport noise programs. In addition, airports are required to prepare EISs when planning construction; SIPs that are based on the findings of an EIS are also eligible for federal funding.

3.1.1 Airport Planning and the Community

The Part 150 study and EIS processes are interactive and seek input from both aviation interests and community representatives to develop recommended actions to resolve noise issues. As noted in 14 CFR Part 150, development of the recommended actions must include public participation in the form of public hearings, workshops, and/or community meetings, which are held “in consideration of the local community interest.”²

Public hearings and community meetings provide a formal setting for citizens to provide comments to decision-making bodies. Typically, hearing and meeting minutes are public documents and are available for residents to review. Public workshops are generally more informal, with program team members interacting with the public on a one-on-one basis. Short presentations may be given at these meetings. Their intent is to relay program information to the public and to solicit public comment. Public participation in the Part 150 study, whether it is in the form of hearings, workshops, or meetings, should be held at different times during the week and weekend to ensure that a broad cross section of the community has the ability to attend. Based on airport size, funding, and the needs of the program, the hearings, workshops, and community meetings should be advertised in local newspapers, community newsletters, magazines, television, and/or radio.

Some programs take community involvement in the Part 150 study a step further and establish advisory panels consisting of local officials, concerned citizens, and community groups. The advisory panels serve as sounding boards for recommendations, provide assistance and guidance in soliciting community feedback, and ensure that the views of the community are adequately addressed.

3.1.2 The Beginning of Community Expectations

A shared sense of ownership is formed when citizens are encouraged to participate in the development of policy. Because the Part 150 study and EIS processes are designed to encourage public comment and participation, the community is able to take an active role in the development of recommendations. When this occurs, the community becomes engaged, takes ownership, and ultimately forms expectations. The final published documents are available to the public. Thereafter, the recommended actions become the basis of the community’s expectations for the sound insulation program.

It is important to note that the community may form expectations before the planning results are published. Expectations can be based on perceptions of the city, the airport, the consultant team, and so forth. These expectations can be positive or negative and may be formed through word of mouth or personal experience.

A. Deconstructing Mistrust and Managing Community Expectations

There is considerable evidence that many Americans possess a broad-based distrust of government and government programs, including sound insulation programs. According to the

² U.S. DOT, FAA, 14 CFR Part 150, Amendment 150-4, Airport Noise Compatibility Planning; Final Rule, September 24, 2004.

Pew Research Center, a dismal economy, an unhappy public, partisan-based backlash, and discontent with Congress and elected officials have created what Pew calls “a perfect storm of conditions” associated with government distrust.³ The Pew survey, which was published in April 2010, reports that just 22% of Americans say they can trust the federal government almost always or most of the time.

A proactive approach to sound insulation programs, one that educates the community and establishes shared expectations, may help reduce trust issues that exist among residential and nonresidential property owners. Openness to engaging the community in a way that builds trust and creates a positive working relationship can define success and is essential to managing community expectations. Part of openness is being candid and realistic about what the sponsor can or cannot do to change the noise environment around the airport.

At the onset of sound insulation programs, it is critical to portray the program in a positive manner. Sound insulation is one of the most tangible and effective means of providing relief for those affected by airport noise. Professional and responsive community outreach efforts set the tone for the program as a whole and can go a long way toward providing successful sound insulation.

3.1.3 ACRP Report 15

In light of trust issues that exist with government programs, there is an increased desire among the public to participate in decisions that will affect them. There is also a demand for the policy development process to incorporate input from diverse sources, especially from those involved or affected by the proposed decisions. *ACRP Report 15: Aircraft Noise: A Toolkit for Managing Community Expectations* clearly articulates the importance of engaging the public in the policy development process.

Engagement creates opportunities to deliver improved recommendations. It establishes a more consistent framework for both airport staff and policy makers to make more informed decisions about important issues. It fosters enthusiasm and excitement about best planning practices, and involves the public in important policy considerations. Engagement advances the airport staff’s credibility and contributes to an atmosphere of trust. The public feels more like they are part of the solution, rather than pawns being manipulated through a jaded set of procedures. As airport planners and managers engage a community, their capacities for brainstorming and knowledge are extended, and they grow as public servants.

Public engagement is not enough. As *ACRP Report 15* outlines, public mistrust of the airport and its motives are at the foundation of most airport conflicts. Therefore, consistent two-way communication that is open and transparent needs to take place in order to establish trust among program participants and community groups.

Trust and respect are the keys to a long-term relationship between the airport and community groups. They require proactive involvement with the public and other interest groups using interactive techniques. Although the relationship may at times shift from collaborative to adversarial, efforts toward building trust and respect through engaged communications will ultimately result in an understanding of each party’s position.

To get ideas for successful ways to build trust and approach community engagement, it might be helpful to read Chapter 4 of *ACRP Report 15, Community Engagement Strategies and Techniques*. Additionally, Chapter 5 of that report provides case studies of airport/stakeholder communication. It may prove beneficial for airport sponsors or program consultants to compare the communications approach in the case studies with their own communications plan.

³Distrust, Discontent, Anger and Partisan Rancor: The People and Their Government, Pew Research Center, April 18, 2010, <http://pewresearch.org/pubs/1569/trust-in-government-distrust-discontent-anger-partisan-rancor>.

3.2 Participation

Sound insulation programs are offered to the public on a voluntary basis. Without willing, eligible participants, sound insulation programs would not exist. To attract participants, a demographic analysis should be performed.

3.2.1 Demographics and Why They Matter

Demographics are data that describe individuals by age, race, gender, ethnicity, economic status, income, education, social class, and so forth. In order to understand their communities' demographics, sponsors should research the noise-affected neighborhoods to identify the particulars of the target population. This can be accomplished through door-to-door campaigns, mailings, surveys, reviewing census reports, and so forth. Information concerning the structure and dynamics of the target population is key to identifying and anticipating community needs, establishing program goals, developing action plans, and measuring the success of the program.

It is important to understand how demographics may affect a person's willingness to participate in a sound insulation program. The demographic makeup of a community dictates the types of community outreach methods that will be most effective in building trust, creating program buy-in, and attracting and retaining participants.

3.2.2 Residential Versus Nonresidential Property Owners

When conducting community outreach to residential property owners, sponsors should consider age, gender, marital status, education level, occupation, household income, ethnic background, and geographic location. The more specific the group, the easier it is to identify their collective wants and needs. Community outreach efforts to nonresidential property owners should take into consideration the type of facility and organization, number of staff, demographics of facility users, and geographic location. Leaders of public institutions are interested in how a program will affect their ability to provide service and how it will affect residents who rely on their facility for service.

3.2.3 Ethnic Makeup

Many sound insulation programs exist in ethnic neighborhoods, and often the ethnic makeup of these neighborhoods varies in relation to geographic area. Generally, neighborhoods surrounding airports in the South and Southwest region have a higher Hispanic or African-American concentration. In comparison, neighborhoods surrounding Midwest and Northeast airports consist of a majority Caucasian population.

The ethnic makeup of noise-affected neighborhoods plays an important role in determining what types of community outreach efforts to employ.

Community outreach to a predominately Hispanic or non-Caucasian population involves understanding the cultural and social characteristics of the population in general, in addition to the specific target community. Depending on the ethnic background of the targeted demographic, it may be necessary to adapt the culture and language of collateral materials. Some programs with a large Hispanic target population provide Spanish translations for all collateral materials. Additionally, in order to increase program comprehension, it may be necessary to use qualified interpreters to transform idioms, colloquialisms, and other culturally specific references into analogous statements that individuals will understand.

3.2.4 Economic Makeup

The economic makeup of noise-affected neighborhoods plays an important role in determining what types of community outreach efforts to employ.

Depending on the education level, occupation, and household income of the targeted demographic, it may be necessary to adapt the message of collateral materials to increase program understanding. The message should be clear, sharp, and above all, understandable. Program sponsors should choose the language and content to which their audience relates and that it expects. The economic makeup of the noise-affected neighborhoods may also affect how sponsors attempt to contact participants. For example, some property owners may not own a computer or phone; therefore, electronic communication or phone calls will prove futile. In this case, sponsors should employ outreach techniques such as mailings, face-to-face interaction, community events, or public workshops and meetings.

3.2.5 Other Demographic Considerations

The age of an individual may affect the outreach approach. If a homeowner is elderly, more face-to-face meetings may be necessary in order to explain the program, obtain required documents, and so forth. An elderly person may ask that the sponsor deal directly with a family member because the process is otherwise too difficult or time consuming. Gender may also be a factor. A female homeowner, for instance, may feel more comfortable dealing with a female program representative. Since the outreach process includes many meetings that take place in the home, some female homeowners may not want to meet alone in their home with a male program representative.

3.2.6 Best Practice Recommendations: Participation

1. Determine the demographic composition of the noise-affected neighborhoods.
2. Employ a local person on the outreach team who is familiar with the noise-affected neighborhoods in question, knows the people and neighborhoods within the noise boundary, and is aware of the issues that the community feels are important.

3.3 Collateral Materials

One of the best ways to increase visibility, deliver information, and strengthen program identity is through the use of collateral materials. Effective collateral materials communicate the right messages in the most efficient manner possible. They are consistent in message, style, and tone, and are produced with sensitivity to the ethnic diversity of the noise-affected neighborhoods. Collateral materials can be printed or developed for online formats, and they vary based on airport size, funding, and the needs of the program.

Collateral materials for sound insulation programs are divided into two general types: required documents and informational materials.

3.3.1 Required Documents

Because most sound insulation programs are jointly funded by the FAA and an airport sponsor, certain legal documents may be required for program participation. It is recommended that

sponsors consult with the FAA to determine the required documents necessary for program participation.

Required documents vary based on airport size, funding, and the needs of the program. Required documents for sound insulation programs typically include a program application, participation agreement, avigation easement, and homeowner acknowledgement of work to be performed. See Section 2.4.3 of these guidelines for more information about these documents.

All signed required documents must be in English. However, some sound insulation programs provide translated documents to residential and nonresidential property owners to increase comprehension. If there is a need to integrate translations into required documents, sponsors should pay special attention to the translation of legal documents. To ensure that the intended meaning of all legal documents is presented accurately, it is important to hire a qualified, professional translator with experience translating legal documents.

3.3.2 Informational Materials

Collateral materials for sound insulation programs can be internal and external in nature. Internal collateral materials serve as education tools for team members. It is essential that team members understand the program and its benefits and are able to communicate that understanding to the public. External collateral materials are designed for noise-affected neighborhoods and communicate a clear, consistent program message. The better they are designed and targeted, the more effective they will be.

A. Internal Materials

Internal informational materials educate team members with respect to the program's goals and expectations, define their individual roles and responsibilities, dictate appropriate standards of conduct and dress when they are representing the program in the community, and provide team members with a consistent message to enable them to speak with one voice about the program.

Consistent messaging creates team cohesion and builds trust, which is essential to empower team members to speak with authority about the program. As noted in *The Leadership Experience* by Richard L. Daft and Patricia G. Lane, "Trust is an essential element in the effective leader-follower relationships because it inspires collaboration and commitment to common goals."⁴

Examples of internal informational materials produced for sound insulation programs are policy and procedures manuals, codes of conduct, partnering session handouts, and FAQ sheets.

B. External Materials

External informational materials are designed to increase program comprehension, raise awareness, and drive participation. If shared with someone prior to a face-to-face or in-home meeting, external informational materials create the first impression of the program. If used as a leave-behind after a presentation or event, the materials become the calling card by which the program is remembered.

External informational materials should vary in nature and type, depending on airport size, funding, and the needs of the program. Examples of external informational materials produced for sound insulation programs are informational letters, legal documents, handouts, quarterly newsletters, customer satisfaction surveys, pamphlets, press releases, booklets, badges, binders, brochures, videos, and logoed T-shirts and hats.

⁴Richard L. Daft and Patricia G. Lane, *The Leadership Experience*, 2nd ed. Cincinnati: South-Western Pub, 2001, p. 264.

Regardless of format or type, effective external informational materials are designed with four basic elements in mind: brand identity, cultural diversity, language, and audience.

Brand Identity: Consistent Message, Style, and Tone. Strong brand awareness within noise-affected neighborhoods helps sound insulation programs establish a positive connection with the community as trusted resources to residents. Successful sound insulation programs pay close attention to branding efforts. In an effort to connect with the community, some programs select bright colors and create an easily identifiable logo.

Informational materials should demonstrate a consistent message, layout, and tone:

1. **Message:** Consistent and transparent messaging helps to build trust, create program buy-in, and maintain satisfaction throughout the duration of the program.
2. **Layout:** A good layout can capture the attention of the audience. Informational materials with appealing graphics are often the determining factor for whether items are actually read. Graphics also serve as guides to take the reader through the materials in the order they are designed to be read.
3. **Tone:** Sometimes written materials are stiff and formal in tone. Other times the tone may be too informal or unprofessional. A neutral tone that is clear, engaging, and understandable is usually very effective; however, consider the target audience. A collateral piece aimed at nonresidential property owners might be most effective with a tone that is more formal. On the other hand, residential property owners might respond better to a collateral piece that is more conversational in tone.

Cultural Diversity. Collateral materials should be produced with sensitivity to the cultural and ethnic diversity of the noise-affected neighborhoods. It is important to determine if there is a need to integrate translations into informational materials. If necessary, employ a translation team with knowledge of program documents and experience translating text to and from the relevant languages.

Clear and Concise Language. Collateral materials should contain clear, concise writing and be easily understood. Technical language may bore an audience or make it difficult for them to understand the overall message of the informational materials. It is important to use straightforward language so that the information is easily understood by the average person. Research has shown that readers faced with big words, long sentences, and large paragraphs are very likely to stop reading; this is not the desired outcome of informational materials. To avoid this, create text that is easy to read. Where appropriate, use subheadings and bullets to break up text. Keep sentences and paragraphs short and manageable.

Targeted Audience. Collateral materials should be created with a specific audience in mind. The more targeted a piece is for an audience, the more effective it will be at getting that audience to take action.

For example, instead of choosing to create one general fact sheet to be provided to several audiences, consider creating tailored versions of the fact sheet for each of the program's target audiences. Successful sound insulation programs create specific informational materials tailored to residential and nonresidential property owners. Examples of informational materials created specifically for residential property owners are general informational brochures, binders with program information that also serve as storage compartments for program information, DVDs that break down each stage of the sound insulation process, and appointment reminder cards. Examples of informational materials created specifically for nonresidential property owners are handouts and presentations for boards of directors, parish councils, and parent and teacher associations, as well as brochures tailored for each nonresidential property being sound insulated.

3.3.3 Sound Insulation Program Information Online

Providing information online increases awareness and exposure because it offers an opportunity to provide complete program information to a large audience in one venue. Online formats are convenient and cost-effective, can increase program credibility and awareness, and can provide general or targeted information, depending on the audience.

A. *Convenient and Cost-Effective*

Providing program information online is immediate and allows for easy access by the public and a quicker response time for team members.

At their convenience, individuals can access program information or contact team members with questions at any time 24 hours a day, 7 days a week. Online formats give sound insulation programs the ability to post required documents such as a program application, which can be downloaded and completed by potential participants. Programs can also post samples of legal documents to give residential and nonresidential property owners a chance to view what is required to participate.

Participants can quickly and easily give feedback on the program and its benefits. Additionally, program representatives can respond to questions more quickly and more cost-effectively than relying on the telephone or mail, which is especially important when dealing with property owners who live out of state. A website is also a cost-effective means to promote the program. It can prove less costly to put program information on a website, where it is easily accessible by everyone, than to advertise using more traditional means.

B. *Trustworthy and Credible*

Providing information online increases program transparency, which helps break down barriers. Sound insulation programs that demonstrate transparent communication are seen as credible and trustworthy, and are more likely to build successful relationships with individuals and community groups.

The creation of a professional and informative website increases program credibility. A website affords a sound insulation program the opportunity to tell the public what the program is about and why it deserves their trust and confidence.

C. *General and Targeted*

General. A program website has become an expected delivery tool for program information. Websites afford sound insulation programs the ability to provide both public, open-access pages, and private, password-protected pages. Public pages can be viewed by everyone and should include program information that is general in nature. Some components that may be included in a public, online format are program information overviews, program boundary maps, program-related photographs, contact information, abatement procedures, and program updates.

Targeted. There are times when sound insulation programs may want to restrict public access. Some sound insulation programs have created password-protected areas on a website where participants can log in and access phase assignments, program updates specific to their property, and dates and times for appointments.

It is important to note that a sound insulation program cannot rely on online formats as the sole source of information to the public. Not every potential participant has access to a computer or the Internet. Information that is listed in an online format should be replicated in printed informational materials. This ensures that the program is doing its due diligence with respect to reaching out to all individuals living within noise-affected neighborhoods.

3.3.4 Best Practice Recommendations: Collateral Material

1. Determine the program documents that are required for participation in an FAA-sponsored sound insulation program.
2. Determine the collateral materials that program staff need to create to increase program awareness and comprehension.
3. With sensitivity to the cultural and ethnic diversity of the noise-affected neighborhoods, determine if there is a need to integrate translations into program materials.
4. Determine the need for a program website to promote awareness and understanding of the sound insulation program; determine which components will be included on the website.

3.4 Communication

Successful public engagement leads to public support and smoother program implementation. How a team communicates or engages the public is an important element in the community outreach process.

A successful communication plan includes strategies on how to notify the public of a program's existence, how to communicate consistently with program participants, and how to provide excellent customer service to keep pace with rising community expectations.

Despite some variation, the vast majority of sound insulation programs employ similar strategies to notify the public of a program's existence. This is not particularly surprising since the means by which team members can approach residents are limited. The central issue aviation planners and program consultants face when deciding on communication strategies is deciding which available tactics are appropriate for the target populations and when those tactics should be used.

3.4.1 Notifying the Public

Sound insulation programs employ a variety of techniques to notify the public of their existence. Notification techniques should vary in nature and type, depending on the demographic of the noise-affected neighborhoods, airport size, funding, and the needs of the program.

Typical techniques employed by sound insulation programs are written correspondence, telephone calls, one-on-one home/property visits, canvassing the neighborhood through knock-and-talk campaigns, advertisements in newspapers and other publications, videos, public service announcements, public meetings, community meetings, open houses, workshops, community events, training seminars, and group presentations to boards of directors, school boards, parents, community groups, neighborhood associations, local nonprofit organizations, and parish councils.

Once a sound insulation program begins, it is a good idea to establish a policy that outlines how to address property owners who are ineligible to participate because their homes are outside of the designated boundaries. Some programs send letters to property owners that are adjacent to the noise exposure contour explaining the program and include a current boundary map, illustrating where their property falls in relation to the set boundary.

3.4.2 Communication with Program Participants

Communication with program participants should be consistent, individualized, and frequent.

A. Consistent Communication

Consistent communication, like effective collateral materials, increases program comprehension, awareness, and participation. Consistent communication that is tailored to a target audience is vital to build trust with participating owners.

B. Individualized Communication

Some methods of communication resonate more based on individual preference. Each property owner is unique and may respond better to certain forms of communication. One person may prefer face-to-face communication and request an in-home visit. Another person may like the immediacy of a phone call or e-mail. When dealing with nonresidential properties, it may be necessary to meet with boards that govern the facility. It is up to the program to provide different communication options from which program participants can choose.

It is more effective to communicate with people in their native language. For example, when dealing with a community that mostly speaks Spanish, in addition to providing written materials in Spanish, it may be necessary to employ an interpretation team with experience interpreting in both directions on the spot, without using dictionaries or other supplemental reference materials. It is helpful if the team is able to transform idioms, colloquialisms, and other culturally specific references into analogous statements that audiences will understand. This provides the option of face-to-face meetings for all program participants.

C. Frequent Communication

Frequent communication and follow-through increase program satisfaction rates among participants. It is a good idea to develop a communication plan among team members that outlines how to properly address property owners and establishes reasonable time frames for responding to property owners' questions and concerns. Successful sound insulation programs assign one contact to every residential and nonresidential property owner. That contact is involved with the property owner, explaining the program and answering questions from the very beginning of the process through program completion. The contact arranges and attends all appointments with participants and addresses special needs as they arise.

Listening. It is important to remember that listening is a part of communication. A key part of listening is the ability to respond appropriately to what is being said. This means listening to the problem and responding in an empathetic tone using nonverbal behavior that demonstrates concern and attentiveness. Effective listening means getting at the heart of the issue. Effective listening makes the property owner feel valued. When in doubt, treat the property owner like a family member.

3.4.3 Customer Service Expectations

A. Changing Expectations

The Internet has increased the public's need for immediate information and communication, which has resulted in changing customer service expectations. There are more than 2.4 billion Internet users throughout the world.^{5,6} Successful sound insulation programs realize that these

⁵<http://www.internetworldstats.com/stats.htm> pulled, accessed April 2012.

⁶Consumer Expectations are Changing, Forcing Contact Center Change, Interactive Intelligence, Susan J. Campbell, December 04, 2007, <http://callcenterinfo.tmcnet.com/analysis/articles/15769-consumer-expectations-changing-forcing-contact-center-change.htm>.

numbers indicate the public is online and on-the-go. To keep pace with technology, sound insulation programs use electronic communication as a means to communicate with participants on a much more frequent basis. Electronic communication increases the immediacy with which team members can respond to participants. It also allows immediate community response, allowing team members to gauge, in real-time, how well they are responding to the needs of participants.

Even as technological advances continue, participants still value the basic elements of excellent customer service: be available, be attentive, be resourceful, and be honest.

Be Available. Make sure team members are available to address issues or answer questions. If a property owner inquires in person or via e-mail, it is important that team members respond in a timely manner.

Be Attentive. The public wants to be recognized quickly, politely, and with respect. Make customer service a program priority among team members and sub-consultants.

Be Resourceful. Inevitably, a sound insulation program will encounter unexpected issues. It is important to take a fast, flexible approach when this occurs. Prompt and creative problem solving can be the difference between a property owner who is upset and one who appreciates the extra attention to detail.

Be Honest. Keep it simple; do not make promises that cannot be kept. Avoid unrealistic expectations by providing consistent, transparent communication and by educating the community about what is feasible and what constraints to action are imposed by regulation.

3.4.4 Best Practice Recommendations: Communication

1. Determine the methods the program will employ to notify the public of the program's existence.
2. Determine the method (e.g., phone calls, face-to-face communication, e-mail) and frequency of communication with program participants.
3. With sensitivity to the cultural and ethnic diversity of the noise-affected neighborhoods, determine if there is a need to use translators to achieve greater program understanding and awareness.
4. Employ a local person on the outreach team who is familiar with the noise-affected neighborhoods in question.

3.5 Satisfaction Rates

Success comes in many forms and is defined in different ways. In sound insulation terms, program success is typically achieved if participants remain happy and involved throughout the duration of a program, from the initial community outreach efforts through construction completion. Often, public opinion plays a large role in determining the success or failure of a program. Successful sound insulation programs identify ways to create positive public perception and combat negative opposition.

Sound insulation programs frequently monitor and measure their program processes. Satisfaction surveys serve as an effective tool in the community outreach arsenal to gauge program performance.

3.5.1 Public Perception

Public perception goes a long way in attracting and maintaining program participants and in validating the success of the program as a whole.

A. Creating a Positive Public Perception

One way to create positive public perception is to engage active community groups or non-profit organizations. Discussions with these groups may shed light on certain community needs that are not being met. This engagement can also provide an opportunity for a sound insulation program to work in collaboration with existing groups to provide additional services. This creates an open atmosphere and makes these groups feel vested in the process, thus promoting program understanding and satisfaction.

B. Combating Opposition

If a sound insulation program faces opposition, a negative public perception can be formed. Opposition often stems from misinformation or misunderstanding. The first step in dealing with community opposition is to listen to the concerns of the community. Listening to the other side of the issue and understanding what causes another person to disagree demonstrates respect for his or her beliefs and permits an effective response.

Some people object to sound insulation programs because they feel they have been left out of the process. To avoid this, team members should make every effort possible to involve representatives of all areas of the community from the earliest discussions about the program. Some people may oppose a policy because they have questions about its necessity, what is being proposed, or how the plan will be implemented. Team members who listen to their concerns and provide consistent, transparent information can transform some of these critics into supporters. Other times, people may be unsupportive because their property is not eligible to participate. In this instance, it is important to clearly articulate the program eligibility requirements and restraints. Honest communication goes a long way in dispelling myths and building trust.

3.5.2 Satisfaction Survey

Successful sound insulation programs recognize the need to continually improve their procedures in order to maintain high customer satisfaction. One direct way of determining whether property owners are satisfied is to simply ask them.

Satisfaction surveys are an important community outreach tool employed by many sound insulation programs to gauge overall program performance. A satisfaction survey should be detailed and should ask property owners to rate or comment on each step of the sound insulation process. This ensures that team members will be able to evaluate the services provided and identify specific areas that work well and those that can be improved. It also helps staff understand and eliminate barriers and obstacles that may affect satisfaction levels among program participants.

A. Timing

The best time to conduct a satisfaction survey is when the experience is fresh in participants' minds. Waiting too long to administer a survey may result in less accurate responses. Time can play tricks on peoples' memories; a participant may forget certain items or confuse a sound insulation program with something else. It is important to conduct the survey as soon as construction is completed.

B. Delivery Method

The preferred delivery method for a satisfaction survey varies from program to program. Some sound insulation programs prefer hand delivery because it is more personal. Other programs send

property owners satisfaction surveys by U.S. mail or e-mail. Still others post a satisfaction survey on a web page, allowing participants the option to download and complete it.

To obtain the most accurate, honest information, it is widely agreed among consultants and sponsors that property owners should be able to complete the survey anonymously.

3.5.3 Best Practice Recommendations: Satisfaction Rates

1. Identify the active community groups and nonprofit organizations within the program boundary.
2. Determine which methods will be employed to reach out to those active community groups and nonprofit groups.
3. Determine which methods will be employed to administer a satisfaction survey to program participants.

3.6 Media

The media is an essential vehicle for disseminating information to the community. The media is typically viewed as an impartial source of information. If used properly, it can provide program information, promote credibility, and develop community buy-in.

3.6.1 Exposure

The power of the media is a tremendous asset when it comes to getting a message out to the public. Gaining exposure through the media is free and often helps boost credibility and increase program legitimacy.

3.6.2 Media Strategies

Some sound insulation programs actively seek out the media, while others do not. Before spending time and energy developing media strategies, the program sponsor and consultants should meet to determine if the airport wants or needs media attention for the program.

Effective media strategies deliver a consistent, transparent message to increase program awareness and alleviate the spread of misinformation that often becomes a barrier to understanding or implementation.

Strategies can be styled to meet varying levels of interest. Depending on the program, its budget, and the complexity of the message, media strategies may include hosting a community event or the preparation and placement of news articles or press releases in independent publications (e.g., community newsletters, city council reports, local newspapers, and magazines). These strategies can occur at major project milestones to convey program awareness, education, and success.

A. Community Events

Hosting community events is another avenue to attract media attention. Community events not only provide a resource to residents living within noise-affected neighborhoods, they also help sound insulation programs increase visibility and participation. Community events vary in nature and type, depending on the needs of the neighborhoods and communities. Some

examples of community activities hosted by sound insulation programs include paint-a-home events where team members paint homes needing refurbishing, neighborhood and park clean-ups where team members remove trash and vegetation to help beautify areas, carnivals and fairs where team members provide free games and food to local residents, and adopt-a-class/family events where team members purchase gifts and goodies for needy children during the holidays. Other community events that may attract media attention include informational meetings and presentations to homeowners, community groups, and agencies. Additionally, milestone events that highlight a specific program achievement, such as the sound mitigation of a program's 100th home or closeout events that celebrate the completion of a program, may garner media attention as well.

B. News Articles/Press Releases

Sound insulation programs are at a great advantage when deciding to pitch articles or press releases to the local news because local news networks often tell stories that have a human interest angle. Many sound insulation programs have access to hundreds of participants with interesting and compelling stories. Sound insulation programs can help bring attention to these stories while playing a secondary role in the news piece as part of providing sound insulation service.

3.6.3 Best Practice Recommendations: Media

1. The program sponsor and consultant should work together to identify and develop media strategies to provide program information, promote credibility, and develop community buy-in.
2. The program sponsor and consultant should work together to develop community events or projects in an effort to garner positive publicity and build relationships within the community.



CHAPTER 4

Acoustical Engineering

This chapter provides guidance for meeting FAA acoustical requirements for SIPs, an overview of the acoustical engineer's role on the SIP team, and a general background to the acoustical concepts, metrics, and nomenclature used for airport noise, which is important to understanding how noise is perceived, measured, and depicted. Noise is defined as unwanted sound and is therefore a relative term that depends on the disposition of the individual listener as well as the sound source.

The FAA employs the DNL noise exposure metric, established by the Environmental Protection Agency (EPA) in 1974, for assessing all community noise impact in the United States.¹ The FAA threshold of significance, based on extensive psychoacoustic research, is that degree of noise exposure at which the community becomes "highly annoyed." This exposure has been established as a DNL of 65 dB.² Thus the FAA has established an objective numerical noise exposure level based on subjective response research results.

A lower local standard (e.g., DNL 60 dB) may be used for Part 150 purposes if the standard is formally adopted by the local jurisdiction for land-use compatibility and the airport sponsor has incorporated it (although the interior noise level standard of 45 dB does not change). Where a lower local noise standard is adopted outside of the Part 150 process, 49 USC 47141 requires that the land use compatibility plan be developed cooperatively by the airport sponsor and local jurisdiction to be eligible for a grant. Additional information on these requirements is addressed in Paragraph 810b. **Noise Exposure Maps used for Noise Insulation Programs must be current.**³

4.1 Introduction and Acoustic Fundamentals

Airborne sound is a rapid fluctuation of air pressure and local air velocity. Sound has properties of both fluids and waves. It propagates outward from its source at high speed, bends around interposing structures, is partially reflected and partially absorbed by incident surfaces, and radiates through structures, which attenuate (i.e., reduce) the transmitted sound. Improved interior NLR (the difference in sound level from exterior to interior) is the objective of SIPs, and this NLR is achieved by retrofitting structures with building elements having higher sound transmission loss (TL) properties.

¹The U.S. EPA Office of Noise Abatement and Control, *Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety*, EPA/ONAC 550/9-74-004, March 1974.

²The Federal Interagency Committee on Urban Noise issued its report entitled *Guidelines for Considering Noise in Land Use Planning and Control* in June 1980. This report established the federal government's DNL 65 dB standard and related guidelines.

³U.S. DOT, FAA, PGL 12-09, August 17, 2012, Attachment 1, §812 (b)(2), p. 1-2.

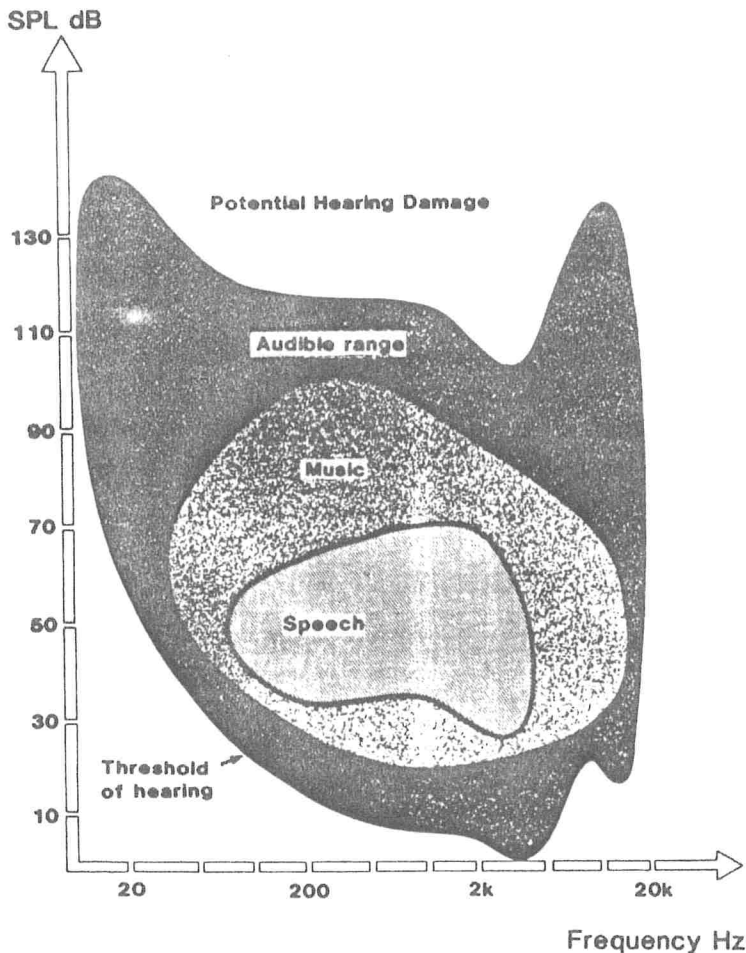
Three aspects of noise are important in determining subjective response:

1. Level (i.e., magnitude or loudness) of the sound.
2. The frequency composition or spectrum of the sound.
3. The variation in sound level with time.

4.1.1 Sound Perception and Combination of Sound Levels

Sound is perceived in a very complex fashion by the human ear as we detect and assimilate sound level, sound frequency, and sound variation over time. Sound levels are measured and expressed in decibels, with 0 dB roughly equal to that level at the threshold of hearing. Sound is a measure of the pressure fluctuations per second, measured in units of hertz (Hz). Most sounds do not consist of a single frequency but are composed of a broad band of frequencies differing in level. The characterization of sound level magnitude with respect to frequency is the sound spectrum. Figure 4.1 depicts the audible range of sound spectra for various types of sounds.

Changes in sound level and combinations of sound levels are nonlinear and do not behave as most other physical phenomena. Because the level and frequency of sound are perceived in a nonlinear way, the decibel scale is used to describe sound levels; the frequency scale is also measured in logarithmic increments. Decibels, measuring sound energy, combine logarithmically.



Courtesy of Charles M. Salter Associates, Inc.

Figure 4.1. Range of sound spectra.

Table 4.1. Decibel addition used in community noise prediction.

Rule		Example		
Difference in Two Sound Levels	Sum of Sound Levels	Level A	Level B	Level A + B
0–1 dB	Highest + 3 dB	86 dB	87 dB	90 dB
2–4 dB	Highest + 2 dB	84 dB	87 dB	89 dB
5–9 dB	Highest + 1 dB	80 dB	87 dB	88 dB
>9 dB	Highest	77 dB	87 dB	87 dB

A doubling of sound energy (for instance, from two identical automobiles passing simultaneously) creates a 3-dB increase; the resultant sound level is the sound level from a single passing automobile plus 3 dB. It would take 10 identical cars passing by simultaneously to be judged as twice as loud as the single car pass-by, though this would be a tenfold, or 10-dB, increase in sound level. The rules and examples for decibel addition used in community noise prediction are given in Table 4.1.

4.1.2 Subjective Response to Noise

The effects of noise on people can be classified into three general categories:

1. Interference with activities such as speech, sleep, and learning.
2. Physiological effects such as anxiety or hearing loss.
3. Subjective effects of annoyance, nuisance, and dissatisfaction.

No universal measure for the subjective effects of noise has been developed, nor does a measure exist for human reactions from noise annoyance. This is primarily due to the wide variation of individual attitude regarding noise sources. For aircraft noise, typical reactions vary from annoyance to anxiety to fear.

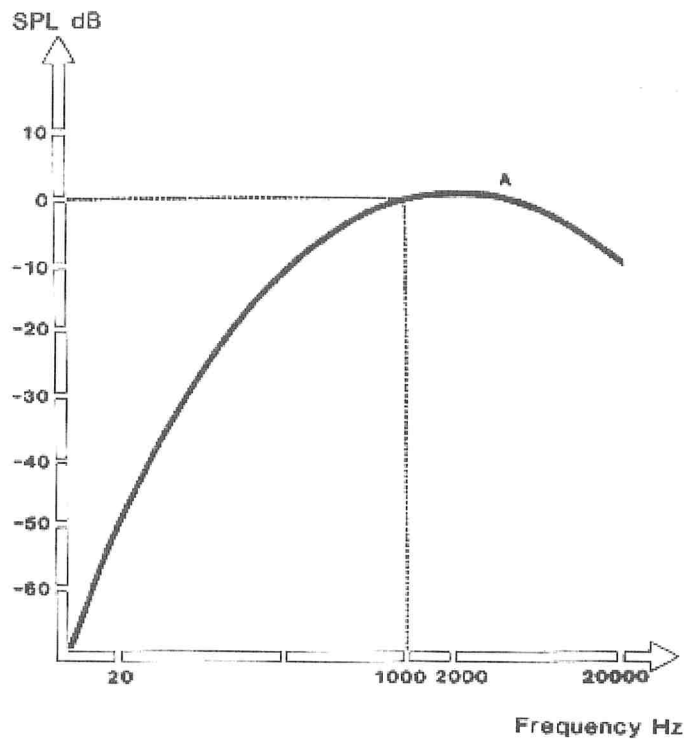
An important factor in assessing a person's subjective reaction is to compare the new noise environment to the prior noise environment. In general, the more a new noise exceeds the prior noise, the less acceptable it is. Therefore, a new noise source will be judged more annoying in a quiet area than it would be in a noisier location. There are two types of noise impact:

1. Absolute impacts, whereby noise level or noise exposure exceeds a specified numerical standard, and
2. Relative impacts, whereby noise level or noise exposure increases by a specified value.

Changes in the noise environment cause a relative impact; the magnitude of a noise environment causes an absolute impact. Most people acclimate somewhat to their noise environment.

4.1.3 Frequency Weighting

Many rating methods exist to analyze sounds of different spectra. The simplest method, A-weighting, is generally used so that measurements can be made and noise impacts readily assessed using basic acoustical instrumentation. This method evaluates audible frequencies by using a single weighting filter that progressively de-emphasizes frequency components below 1000 Hz and above 5000 Hz. This frequency bias reflects the relative decreased human sensitivity to low frequencies and to extreme high frequencies. A-weighting is applied by an electrical filter in all U.S. and international standard sound level meters. Figure 4.2 shows the A-weighted network.



Courtesy of Charles M. Salter Associates, Inc.

Figure 4.2. A-weighted network.

4.1.4 Noise Exposure

Noise exposure refers to a measure of noise over a period of time, whereas *noise level* is a value at an instant in time. Although a single sound level may adequately describe the noise at any instant in time, airport and other community noise levels vary continuously. Most community noise is produced by many noise sources, which create a relatively steady background noise that has no identifiable source. These sources change gradually throughout the day and include traffic, wind through foliage, and distant industrial activities. Superimposed on this slowly varying background is a succession of identifiable noise events of brief duration. These include nearby activities, such as single vehicle pass-bys or aircraft flyovers, which cause the community noise level to vary from instant to instant. This fluctuating series of noise levels combines to form the noise exposure profile of a community.

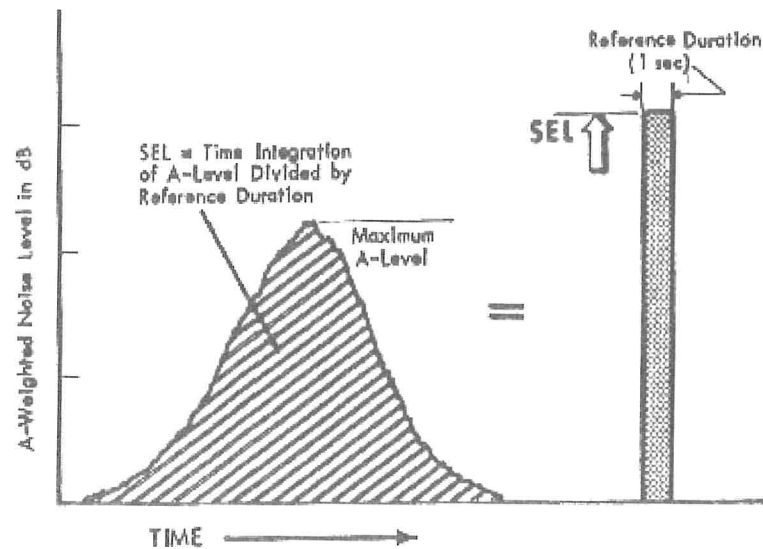
For purposes of quantifying noise that varies over a period of time, a standard term, *equivalent sound level*, has been adopted in the United States and internationally.^{4,5} Equivalent sound level is a single number and is typically referenced by the symbol L_{eq} . Equivalent sound level is an energy average that takes varying sound levels of a time period and describes them as one constant noise level (i.e., the total sound energy divided by the duration). It is a construction of that constant sound level containing the same acoustic energy as the varying sound level during the same time period.

Discrete, short-duration transient noise events, such as aircraft flyovers, may be described by their maximum A-weighted noise level or by their sound exposure level (SEL).⁶ The SEL value is preferred over maximum noise levels in defining individual events because measured results

⁴ American National Standards Institute, *ANSI S1.8*, American National Standard Reference Quantities for Acoustical Levels.

⁵ International Organization for Standardization, *ISO 1996-1:2003*, Acoustics – Description, measurement and assessment of environmental noise – Part 1: Basic quantities and assessment procedures.

⁶ See note 1.



Courtesy of Charles M. Salter Associates, Inc.

Figure 4.3. Sound exposure level.

may be more reliably repeated and because the duration of the transient event is incorporated into the measure (thereby better relating to subjective response). Maximum levels of transient events vary with instantaneous propagation, measurement system time constant, and receiver conditions, while a total energy measure, like SEL, is more stable. The SEL of a transient event is a measure of the acoustic energy normalized to a constant duration of 1 second. The SEL differs from the L_{eq} in that SEL is the constant sound level containing the same acoustic energy as a 1-second event, whereas the L_{eq} is the constant sound level containing the same acoustic energy over the entire measurement period. The SEL may be considered identical to the California standard single event noise exposure level (SENEL).⁷ Figure 4.3 depicts how SEL is computed.

SEL values may be summed on an energy basis to compute L_{eq} values over any period of time. This is useful for modeling noise in areas exposed to numerous transient noise events, such as communities around airports. Hourly L_{eq} values are called hourly noise levels (HNLs).

In determining the daily measure of community noise, it is important to account for the difference in human response to daytime and nighttime noise. During the night, people are more often at home and exterior background noise levels are generally lower than during the day, which causes exterior noise intrusions to become more noticeable. For these reasons, most people are more sensitive to noise at night than during the day.

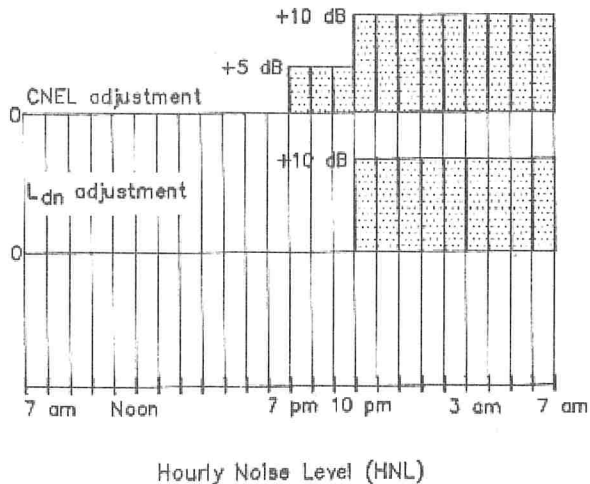
To account for human sensitivity to nighttime noise, the DNL (symbol L_{dn})⁸ descriptor is a U.S. and international standard adopted by the EPA in 1974 that describes community noise exposure from all sources. The DNL represents the 24-hour, A-weighted equivalent sound level with a 10-dB penalty added for nighttime noise between 10:00 p.m. and 7:00 a.m. The FAA has officially used DNL as its standard since 1981.

In California, the CNEL⁹ has been the adopted standard since 1972. DNL and CNEL are typically computed by energy summation of HNL values, with the proper adjustment applied for the period of evening or night. CNEL is computed identically to DNL but with a tripling of the

⁷ California Code of Regulations, 21 CCR Title 21.

⁸ See note 1.

⁹ See note 5.



Courtesy of Charles M. Salter Associates, Inc.

Figure 4.4. Hourly noise levels and annual metrics.

evening (i.e., 7:00 p.m. to 10:00 p.m.) noise.¹⁰ The CNEL value is typically less than 1 dB above the DNL value. Since DNL and CNEL are so similar, all regulations are applied the same to both; only DNL will be referenced throughout these guidelines, with the understanding that CNEL is accepted identically in California. Noise exposure measures such as L_{eq} , SEL, HNL, DNL, and CNEL are all A-weighted with units expressed in decibels. Figure 4.4 depicts the adjustments made to DNL and CNEL for the various periods of the day.

4.2 Basics of FAA-Sponsored Sound Insulation

Understanding the acoustical impact environment created by transportation and applying the principles of noise reduction to affected buildings are the work of sound insulation programs. In order to achieve conformity in efforts across the country in varying climates and construction typologies, that work has to meet a consistent design standard.

4.2.1 FAA Acoustical Design Objectives

There are two design objectives for eligible homes in sound insulation programs:

1. A target post-retrofit interior DNL of 45 dB in all habitable rooms.
2. A minimum NLR improvement of 5 dB.

A. Basis for Design Objectives: Subjective Response

The reason for the 5-dB NLR improvement criterion is to ensure a noticeable improvement in interior noise. A series of perception tests¹¹ revealed that changes in noise exposure were perceived as follows:

1. Except under special conditions, a change in sound level of 1 dB cannot be perceived.
2. Outside of the laboratory, a 3-dB change is considered to be a just-noticeable difference.

¹⁰ 5 dB is often shown for simplicity, but the accurate formula is $10 \cdot \log 3 = 4.8$ dB.

¹¹ See S. S. Stevens, "On the Psychophysical Law," *Psychological Review*, 64: 153–181; S. S. Stevens, "Perceived Level of Noise by Mark VII and Decibels (E)," *Journal of the Acoustical Society of America*, 51: 575–601; E. Zwicker and B. Scharf, "A Model of Loudness Summation," *Psychological Review*, 72: 3–26.

3. An increase or decrease in level of at least 5 dB is required before any noticeable change in response would be expected.
4. A 10-dB increase is subjectively heard as an approximate doubling in loudness.

B. Perceived Airport Noise Exposure, More Complex

However, this perception summary represents special test conditions. These perception tests were made by playing certain fixed broadband sounds to juries of listeners and then immediately changing those levels and noting the juries' average responses to sound level increases and decreases. The changes in perceived airport noise exposure, however, are considerably more complex for two reasons:

1. The spectra of individual aircraft flyovers change substantially between individual events, so the comparison in loudness is complicated by comparing dissimilar sounds. Issues of annoyance, nuisance, dissatisfaction, speech interference, sleep interference, learning impairment, anxiety, and hearing loss all affect subjective response to changes in noise level.
2. More significantly, noise exposure is an integrated measure of sounds over a period of time, whereas sound level is simpler and immediate. Subjective comparison of any sensory values is greatly affected by latency, or the time between events. So comparisons of long-term noise exposure measures, such as DNL, will yield much more varied responses than will the immediate changes in noise level used for this perception test.

The FAA, in establishing performance criteria for SIPs, ensured that sound insulation program treatments would provide an audible improvement in affected buildings.

4.2.2 The Building Envelope

Taking the design objectives into the field and applying them to structures needs further articulation. While a building may have a consistent construction, it is possible for each room to provide a different existing NLR depending on (1) the noise reduction properties of the individual façade building materials exposed to incident aircraft noise, and (2) the area of each individual building material exposed (i.e., ratio of wall to window). This is important in developing and implementing NLR design criteria for SIPs. Design approaches include:

1. Individually design each room to achieve a ≥ 5 -dB Δ NLR and a ≤ 45 -dB DNL.
2. Apply a uniform noise reduction treatment standard to create a homogeneous building envelope using consistent treatments.
3. Provide a hybrid approach where consistent treatments are applied across the building envelope but rooms that need additional treatments to achieve the ≤ 45 -dB DNL will receive additional design attention.

PGL 12-09 is not specific as to which of these design objectives meet FAA noise reduction goals. **Program sponsors and consultants are advised to consult with their local ADO for further clarification regarding this issue.**

Depending on a building's location in the contour and its existing noise reduction capabilities, treatments may need to achieve greater than 5 dB of reduction to meet the interior 45-dB DNL criteria.

In the first approach, each room could have a different existing NLR depending on the ratio and composition of building materials. Achieving a uniform minimum 5-dB treatment could require different treatments for each room to achieve the required NLR.

The second approach allows for use of uniform building materials and construction procedures throughout the program. This provides considerable cost savings in both material and labor.

However, each room receives a slightly different NLR improvement, but each room receives a similar interior noise environment after retrofit.

In the third approach, the exterior envelope of the whole building is reviewed for consistency of construction and building elements, and then individual rooms are verified for specific performance issues. This allows for use of uniform building materials and construction procedures for the majority of the treatments and acknowledges that more retrofit may be needed in limited cases to provide a continuous STC 40 building envelope.

The majority of residential SIPs employ some form of the second or third approaches for treatment design; few programs attempt to achieve specific NLR performance for each room. Consequently, when applying a uniform sound transmission class (STC) performance envelope across a program, older homes and those having poorer pre-retrofit NLR performance will realize a greater NLR improvement (on average 7 dB to 8 dB) than newer and well-maintained homes, which may only realize a 4-dB to 5-dB improvement from the same treatments.

In addition to the NLR properties of basic building elements, another significant noise path is the presence of acoustical leaks, termed *flanking paths*. These are typically cracks or poor seals where air and sound may infiltrate. Flanking may significantly degrade sound insulation performance and requires treatment in every instance. Sound has the property of always infiltrating the weakest spot. It is not feasible to apply excessive acoustical treatment in one location while allowing for flanking in another; therefore, attention will need to be paid to the building envelope beyond the major fenestration openings.

4.2.3 Achieving a Noise Level Reduction of at Least 5 dB

Prior to sound insulation treatments, a structure will typically provide various degrees of noise reduction in various rooms. Corner rooms with three exposed façades, containing large non-sound-rated windows that make up a large percentage of the exposed exterior, will be much noisier inside than a contained first-floor room with a single exposed façade. The solid wall in the basic façade structure, typically stucco or wood siding, has much better sound attenuation properties than non-sound-rated windows. Certain uninsulated façades and lightweight façades (such as those of aluminum and lightweight vinyl) fall short of the standard sound transmission loss level; in these cases the windows provide more noise reduction than the façade. Heavy brick and stucco façades, on the other hand, typically provide more than the standard sound transmission loss level; in these cases the windows provide less noise reduction than does the façade.

Given differences in room exposure, there has been considerable discussion as to how the minimum 5-dB NLR improvement criterion is to be applied in sound insulation programs. Alternative interpretations include:

1. Every room treated must achieve a minimum 5-dB NLR improvement.
2. The average NLR improvement for all tested rooms in a single dwelling must be at least 5 dB.
3. The average NLR for all dwellings in a single project or a single program must be at least 5 dB.

PGL 12-09 is not specific as to which of these three treatment outcomes is consistent with FAA noise reduction goals; however, it does state, “The measurement of interior noise levels is an average for all habitable spaces in a particular residential unit.”¹² This is consistent with the consensus of programs and the FAA offices that the second interpretation is the prevailing objective for programs to meet. **Sponsors and consultants should consult with their local ADO for further clarification regarding this issue.**

¹²U.S. DOT, FAA, PGL 12-09, August 17, 2012, Attachment 1, §812 (b)(1), Table 1 p. 1-3.

Designing for a 5-dB NLR improvement in a room requires the application of technical calculations containing information on the room area, the amount of wall openings, and the projected performance of the new treatments. Some examples of these calculations can be found in the 2005 version of the SIP guidelines.¹³ Rooms with varying amounts of wall openings will necessarily achieve different NLR improvements from a standardized program approach to window and door replacement. Therefore, the acoustical design criterion used in the majority of programs is to achieve a uniform level of noise reduction for the entire building envelope. Thus the non-sound-rated windows are replaced with sound-rated windows whose noise level reduction properties are similar to that of the basic façade.

It would be possible to achieve a full 5-dB NLR improvement for a contained first-floor room with a small window, but this might require retrofit treatment of the façade wall as well as the small window to balance the small ratio of window to wall. Consequently, this would render the small room much quieter than other rooms treated throughout the structure. In this case, meeting the ≤ 45 -dB DNL interior may be sufficient. Most programs test the pre- and post-construction in approximately three rooms in any house. It is reasonable to focus on the major rooms of the house with normal to significant exterior exposure and let the consistent envelope treatment apply to rooms with smaller amounts of noise exposure. This allows for a balanced and uniform noise reduction envelope throughout the structure, using standard and similar building materials and elements throughout the program. This achieves the minimum 5-dB NLR improvement objective for nearly all rooms. In light of PGL 12-09, which requires an average of all treated space, programs will need to make policy decisions about what expense they are willing to incur to go above uniform treatments.

4.2.4 Interior Eligibility Standard

PGL 12-09 has placed renewed emphasis on interior noise levels as a per-building qualification threshold for sound insulation treatment eligibility. This requires an assessment of the existing interior DNL for each residence or structure prior to its acceptance into or rejection from the SIP. This assessment will be conducted by either (1) composite transmission loss (CTL) computation of the existing NLR performance of the residence, or (2) measurement of the actual NLR performance. PGL 12-09 states:

In 1992, FAA adopted guidance on testing frequency, sampling and other statistical measures that can be applied to a neighborhood to estimate the interior noise levels in the residences that are in the 65 dB contour. This information is compiled into the Acoustical Testing Plan. Long standing agency policy is that an airport sponsor must use the 1992 guidance to establish the existing interior noise levels to determine whether or not the building qualifies for sound insulation using AIP.¹⁴

The FAA requires any testing beyond 30% to be justified to the FAA Planning and Environmental Division – Airport Planning and Programming (APP-400).¹⁵ Some programs currently conduct 100% testing for community confidence when excluding properties from treatment.

PGL 12-09 clarifies that an average interior noise level of DNL 45 dB in all habitable rooms is an eligibility criterion for determining whether a structure qualifies for sound insulation. Two potential issues regarding implementation of this eligibility criterion are:

1. The testing methodology needs to accurately measure interior noise levels while taking into account the margin of error that is inherent in the various testing methodologies. The PGL

¹³Department of the Navy, Naval Facilities Engineering Command, *Guidelines for the Sound Insulation of Residences Exposed to Aircraft Operations*, April 2005.

¹⁴U.S. DOT, FAA, PGL 12-09, August 17, 2012, Attachment 1, §812 (c)(2), Table 2, p. 1-6.

¹⁵U.S. DOT, FAA, PGL 12-09, August 17, 2012, Attachment 1, §812 (c)(2), Table 2, p. 1-7.

does not address factoring in a margin of error. There may be homeowners who will be deemed ineligible by testing that has not accounted for a margin of error.

2. The averaging method will inevitably lead to situations where homes will be ineligible for treatment. If interior noise levels of the majority of rooms are above DNL 45 dB but one or more habitable rooms are unusually low, the overall average could result in the structure not being eligible for treatment.

Program sponsors and consultants should refer to their local ADO for further information regarding these issues.

4.2.5 Acoustical Testing Plan

Table 2 of PGL 12-09 specifies criteria that a sponsor must meet in order to be eligible for AIP grant funding. One of the requirements is that the sponsor prepare an acoustical testing plan to determine existing interior noise levels using FAA-adopted guidance as found in *Guidelines for Sound Insulation of Residences Exposed to Aircraft Operations*, October 1992. Table 2 of these guidelines describes a testing and treatment process that starts with the following steps in an initial testing phase:

1. Create an inventory of housing types and locations based on a windshield survey.
2. Develop packages of acoustical treatments specific to each housing type.
3. Test representative samples of each housing type.*
4. Develop acoustical treatments for each housing type that will meet FAA noise reduction goals.
5. Install treatments (although not specifically stated).
6. Conduct post-construction testing to determine if noise reduction goals have been met.
7. Submit a report (the acoustical testing plan) to the ADO describing pre- and post-construction test results along with (if required) any changes to sound insulation treatments for each housing type.
8. After approval of the acoustical testing plan by the ADO, begin the full sound insulation program using the acoustical treatment packages that have been tested and subsequently approved for each housing type.

**Although not specifically stated in the process described by the PGL in item #3, it is assumed that if testing indicates that the average interior noise levels for all habitable rooms of a given housing type is less than a DNL of 45 dB, then this housing type will be deemed ineligible for AIP-funded sound insulation.*

As of the date of this writing, there has been some discussion regarding this process. Some sponsors and consultants suggest that this process may not accurately determine interior noise levels in homes or provide a defensible basis for determining a home's eligibility or ineligibility for treatment. There are two main reasons for this concern:

1. As noted by the 1992 guidelines:

Two houses may be very much alike and yet each will have unique features which require special treatment. While it is useful to discuss, in general terms, typical dwelling categories and classes of modifications, the actual site-specific design requires the services of an acoustics consultant or an acoustics-knowledgeable architect.¹⁶

2. Creating categories of homes in order to predict acoustical performance based solely on a windshield survey and exterior building characteristics does not account for factors such as exterior envelope air infiltration, homeowner modifications (e.g., pet doors, mail slots), and interior finishes that have a direct impact on interior noise levels.

¹⁶ U.S. DOT, FAA, Report No. DOT/FAA/PP-92-5, *Guidelines for the Sound Insulation of Residences Exposed to Aircraft Operations*, October 1992, §3.6.1, page 3-64.

Users of these updated guidelines are advised that further clarification from the FAA may occur.

In response to these issues, a testing strategy is being formulated that uses a combination of typology sample testing with computer modeling. The core concept of this approach is to perform acoustical modeling of all potential program homes to determine the existing outdoor-to-indoor noise reduction (NLR) characteristics of all habitable rooms. Details about existing conditions in the homes that are needed for the modeling are obtained from assessment visits conducted to determine existing conditions and potential primary and secondary treatments at each residence. Thus, homes would not be qualified based on typology or windshield surveys but would be qualified based on actual inspection and modeling of every home.

Ongoing research at the Georgia Institute of Technology is developing refinements to acoustic modeling software such as INSUL and IBANA-Calc¹⁷ that will take into account the spectrum of conditions in existing residential structures that the current PGL testing process does not include. Using acoustic modeling software will provide a higher level of confidence in calculations of interior noise levels that will ultimately provide for a range of benefits, including:

1. Greater confidence from the homeowners that the particulars of their individual homes are being accounted for in determining eligibility and ineligibility.
2. Data that are empirically derived and that identify primary and secondary treatments and assurance that treatments will meet FAA noise reduction criteria.
3. More cost-efficient use of on-site acoustical testing to calibrate and add further information to the acoustical modeling database rather than using acoustical testing to determine the interior noise levels of every habitable space in every potentially eligible home.

Users of these updated guidelines are advised that the use of acoustical modeling as a complementary process to the process described in the PGL is not currently in widespread practice. It should be noted, however, that the 1992 guidelines (the FAA-adopted guidance per the PGL) confirm the value and validity of this approach:

The current noise reduction capability of the dwelling can be determined in one of two ways. Performing field measurements using the methods described in Section 3.3 gives a reliable value for the noise reduction. It may, however, be impractical to take measurements in each dwelling included in the project. Proprietary computerized models are an alternative, and equally valid, tool. In most home sound insulation projects the field measurements are primarily used to provide input data for calibrating the model and to validate the model predictions. The field measurements and model predictions usually agree to within 2 to 3 dB. In general, the more conservative noise reduction value should be used in setting the insulation goals and designing the modification package.¹⁸

Program sponsors and consultants should consult with the ADO responsible for review and approval of their program's acoustical testing plan.

4.3 The Science Behind Evaluating Sound Insulating Building Elements, Materials, and Systems

4.3.1 Sound Transmission Loss Concepts

Sound TL of individual building elements depends on their mass, resiliency, and acoustical decoupling properties, the spectra of the aircraft producing the noise environment, and the angle of incidence of all aircraft noise impinging on each building element on the structure's façade.

¹⁷Nathan Firesheets, Modeling the Transmission Loss of Typical Home Constructions Exposed to Aircraft Noise (Master's Thesis), Georgia Institute of Technology, Atlanta, GA, 2012.

¹⁸U.S. DOT, FAA, Report No. DOT/FAA/PP-92-5, *Guidelines for the Sound Insulation of Residences Exposed to Aircraft Operations*, October 1992, §3.4.1, p. 3-18.

The most fundamental principle of sound TL is the mass law, which gives the TL at each frequency as a function of surface weight. According to the mass law, TL increases linearly with an octave or one-third octave band. This law works well only for limp monolithic (i.e., no composite structure) materials, but also forms the basis for TL properties for all materials and structures. Specifically, all materials and systems exhibit a general trend of increasing TL performance with increasing frequency. That is, higher frequencies are attenuated more effectively than low frequencies in all structures.

Resiliency (or its inverse, stiffness) is an important property for TL in composite materials. Sound does not pass through materials but, rather, impinges on a material and reradiates from the other side at some reduced level. Materials attenuate sound energy through consuming mechanical vibration energy and converting it to small (almost immeasurable) quantities of heat. Thus, the more resilient a composite material, the more energy will be consumed and the greater the sound attenuation.

The third principle in sound attenuation is decoupling, which is a property of composite materials to structurally and acoustically isolate parallel elements of the composite structure. One example of acoustical decoupling is the dual-glazed windows used in SIPs. Here sound impinges on the exterior glazing panel, which must then reradiate the sound through a substantial air space (typically more than an inch) and then through a second layer of glass. This acoustical transmission inefficiency is very effective in reducing sound transmission through the assembly. The glazing panels are in resilient zipper gaskets, which minimize structural coupling through the framing system.¹⁹

High TL is most efficiently achieved by double-wall construction, allowing for greater TL with lighter-weight assemblies. Best results are achieved when the parallel panels are mechanically and acoustically isolated. Mechanical isolation is achieved by independent support of the parallel panels (no structural coupling), and acoustical isolation is achieved by increased air space between the panels. The net TL of two isolated panels may be computed from the individual TL properties of each.²⁰

Several prediction methods may be used to compute the TL properties of building elements and assemblies. These models incorporate the mass, stiffness, geometry, mechanical isolation, and acoustic isolation properties of the building assembly. However, these models do not often yield precise results because of the difficulty in measuring the various properties, particularly stiffness and mechanical isolation. For this reason, laboratory TL testing is required for acoustical materials and assemblies used in SIPs.

4.3.2 Sound Transmission Class Rating

While the TL characteristics of building materials and assemblies may generally be computed with reasonable accuracy and reliability or tested in sample field installations, the best method of ensuring TL performance is acoustical testing in an accredited laboratory and according to American Standard for Testing and Materials (ASTM) standards. Laboratory accreditation is by the National Voluntary Laboratory Accreditation Program (NVLAP) under the oversight of the National Institute of Standards and Technology. Architectural product manufacturers are generally required to submit such laboratory test results for all major building elements in order to obtain approval for use in SIPs.

¹⁹ See note 13, p. 2-6.

²⁰ B. H. Sharp, "Prediction Methods for the Sound Transmission of Building Elements," *Noise Control Engineering*, 11, 5533, 1978.

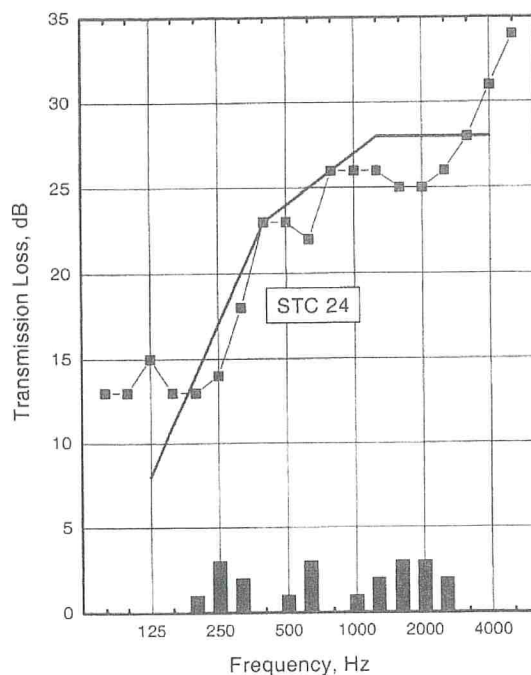


Figure reprinted, with permission, from ASTM E413-10, *Classification for Rating Sound Insulation*, copyright ASTM International, 100 Barr Harbor Drive, West Conshohocken, PA 19428. A copy of the complete standard may be obtained from ASTM International, www.astm.org.

Figure 4.5. STC test result.

The sound TL properties of building elements are tested and reported according to national standards in one-third octave bands, classified as an STC rating.²¹ Each building element, such as a particular window, may be expected to have a unique TL signature represented by 16 TL values from 125 Hz to 4000 Hz. As mentioned in the previous section discussing mass law, the nature of sound attenuation through structures is such that all TL tests have generally up-sloping properties from low frequency to high frequency, indicating generally increasing noise reduction in higher frequencies. Figure 4.5 depicts a typical TL test result.

4.3.3 Transmission Loss Metrics

STC is the oldest and most established rating for the TL properties of building elements and systems. STC is computed by using the standard three-straight-line-segment curve in Figure 4.5 and computing the TL deficiencies (differences in measured TL and curve value) in each of the 24 one-third octave bands. The STC rating is determined as the highest value of the curve at 500 Hz for which the sum of deficiencies does not exceed 32 and no single deficiency exceeds 8. This procedure was developed for two purposes: to consider the subjective response of the human ear at various frequencies with the shape of the segmented curve and to account for the annoyance effects of panel resonance and coincidence dips. These latter effects are most prevalent with lightweight structures, where specific frequencies are reinforced and cause annoying buzzing tones. However, with most building elements of STC 40 or greater, these effects become imperceptible. Coincidence dip is a drop in the TL of a material or assembly at a certain frequency caused by resonance effects.

²¹ ASTM International, ASTM E413, *Classification for Rating Sound Insulation*.

Another TL standard was adopted by ASTM, the outdoor–indoor transmission class (OITC).²² The OITC method is simpler and more easily understood than STC. It was developed specifically to assess the TL properties of materials and systems subjected to transportation noise. Specifically it (1) employs a reference sound spectrum comprised as the average from railroad, freeway, and aircraft noise sources; (2) subtracts the 18 one-third octave band TL values from 80 Hz to 4k Hz; and (3) A-weights the resulting sound spectrum to produce the OITC value. Some SIPs have shown interest in OITC, and some have accepted OITC tests as an option to STC test results.

The sound transmission class metric has withstood the test of time and remains the most commonly used metric for rating the sound transmission loss characteristics of various building materials and systems for SIPs. Many programs are reluctant to require vendors of proven building materials and systems to spend the time and money to retest their established products for the new standard.

4.4 The Acoustical Design Process

The acoustical consultant plays a key role throughout the acoustical design process, extending from the project planning phase through conceptual and detail design, construction consulting, acoustical testing, and project performance reporting to the FAA. In the planning phase of the project, the consultant works with the project team in selecting building materials and acoustical treatment protocols for use in the program, and reviews acoustical test reports from product manufacturers to ensure compliance with the TL standards for the program, which is typically specified using STC performance. Often the consultant will confer with vendors and suppliers to ensure that there have been no changes in the test reports for the design or fabrication of materials or systems.

After selection of program structures for treatment, the acoustical consultant performs pre-retrofit acoustical testing of representative structures in the program. Established or ongoing programs typically test 10% of program structures. Pilot programs or programs with widely variant housing types may test a higher percentage, from 25% to 100%, depending on the amount of data needed to make decisions on treatments. In addition, any special structures, such as historical homes, will likely require specialized acoustical treatment and would be appropriate to test.

Based on test results, the consultant prepares an acoustical conceptual design, which identifies the performance needs for various treatment elements. Acoustical consultant input is particularly important when reviewing exceptions (referred to as *waivers* in some regions) to project acoustical standards, such as homeowner requests to have special building elements (e.g., decorative or stained glass windows) remain rather than be replaced. Incorporating this review may prevent exceptions that would result in nonconformance with the NLR and DNL standards of the program. Following the review, the project architect and engineers develop drawings for each structure to be sound insulated, list specifications for all building materials and systems, and outline project details for on-site construction and installation of building elements and systems. Customized treatments for each residential structure are developed based on a standard set of treatments as well as program policies and procedures. Institutional or public buildings will likely require fully customized treatments. Following are typical acoustical treatments for building elements and systems:

- Replacement of windows with sound-rated windows.
- Replacement of exterior doors into habitable/occupied spaces with sound-rated entry doors, or addition of sound-rated storm doors over new or existing doors. Also, new perimeter gaskets and threshold systems are installed.

²² ASTM, ASTM E1332, Standard Classification of Outdoor-Indoor Transmission Class.

- Addition of attic insulation. Often fiberglass insulation is added by blowing in, although roll out insulation works equally well.
- Addition of vent baffles for outsized gable vents in the attic. Eave vents are typically not treated due to their small size.
- Addition of flex ducting to bath fans and dampers atop kitchen fan exhaust stacks.
- Addition of chimney-top dampers or glass doors on fireplaces.
- Patching and sealing of extraneous protrusions through the façade such as mail slots, pet doors, through-wall air conditioning, and various homeowner modifications.
- Addition of or modification to heating, ventilating, and air conditioning (HVAC) systems to ensure air quality and comfort.
- Addition of secondary glazing to skylights.
- Addition of ceiling or wall materials where needed.

On completion of construction, the acoustical consultant performs post-acoustical testing on the same structures originally tested. Testing locations, procedures, and conditions are replicated to the maximum extent possible in order to determine NLR improvement as accurately and reliably as possible.

The final step in the acoustical design process is preparation of sections of the project's final report that are specific to acoustical treatments. Topics and issues typically covered are structures treated, design criteria, treatments effected, special structures, the pre- and post-retrofit DNL and NLR, and assessment of compliance with the FAA acoustical objectives for the program. These reports are typically submitted to the airport sponsor, which submits the full report to the local FAA ADO. See Chapter 12 for more information about project reporting and closeout.

4.5 Noise Effects

The FAA has accepted the DNL metric exclusively to assess and evaluate airport noise exposure in SIPs. This metric is also the EPA standard and is used almost exclusively in all community noise assessments throughout the United States (though the very similar CNEL is used throughout California). The DNL metric is typically accepted as the best single metric for describing airport noise impacts that may be interfering with speech and sleep and creating adverse learning effects on school children. Certainly, a reduction in interior DNL provides a degree of relief from these impacts.

4.5.1 Improved Speech Communication

The greatest single result from sound insulation is improved speech communication. As mentioned, the greatest noise reduction from sound insulation occurs in the higher frequencies where speech occurs, from 500 Hz to 2,000 Hz. Typical sound insulation results will be from 5 dB to 8 dB in terms of A-weighting, though the improvement in the higher speech frequencies is typically 10 dB or more. Homeowners surveyed after noise retrofit typically cite improved speech communication. They no longer need to interrupt dinner and phone conversations or turn up the TV volume during flyovers. However, there is less improvement in the low-frequency roar, typically about 2 dB, below 500 Hz. But this roar only minimally affects speech communication because it is outside of the speech frequencies and does not mask, or drown out, speech.

4.5.2 Supplemental Noise Metrics

DNL is by far the most widely accepted noise metric and is employed as the standard for all environmental impact assessments throughout the United States for transportation projects.

Other metrics for noise-related impacts such as speech interference and sleep interference may be useful to help evaluate specific use areas such as hospitals, schools, and places of worship. While the interior $DNL \leq 45$ dB and $\Delta NLR \geq 5$ dB metrics are the measurement standards for SIP performance, the use of other metrics is only allowed by the FAA with specific approval in concert with the regional ADO. In part FAA AC 150/5020-1, Noise Control and Compatibility Planning for Airports, states, “it is recommended that additional analysis via single event maximum sound level and/or sound pressure level versus frequency data be used to determine the necessity (and/or eligibility) for soundproofing.”²³

Various noise metrics are available to assist in assessing various noise effects. For speech the most common are speech interference level²⁴ (SIL, the average sound level in the 500-, 1,000-, and 2,000-Hz octave bands) and speech intelligibility index.²⁵ Other metrics have been developed for speech intelligibility, and some are supported by national and international standards, but many of these are overly complex, while others are applied to particular conditions such as assessment of audio systems or HVAC background noise. SIL is used most commonly for its simplicity, and often a simple A-weighted maximum level of 60 dB is used as a design criterion for speech communication in an aircraft noise environment. This is particularly expedient in designing treatments for educational environments where speech intelligibility is critical.

As of 2002, the American National Standards Institute (ANSI) promulgated a national standard for the noise environment in school classrooms: Acoustical Performance Criteria, Design Requirements, and Guidelines for Schools. This standard addresses background noise, room acoustics (the liveliness and acoustical reflectivity of the interior space), and sound insulation in terms of STC. The sound insulation standard depends in part on whether the interior noise from exterior sources exceeds 40 dB for more than 10% of the time during any hour of class. This assessment requires modeling or measurement of the aircraft noise environment. Specifically, the Integrated Noise Model (INM) computer program used to develop the DNL noise contour for the Part 150 study must be rerun using a time-above analysis. Alternatively, continuous measurements may be made in the classroom during the noisiest hour on a typical day.

Sleep interference is another important issue often addressed for aircraft noise environments. A national standard, ANSI S12.9-2008, Quantities and Procedures for Description and Measurement of Environmental Sound—Part 6: Methods for Estimation of Awakenings Associated with Outdoor Noise Events Heard in Homes,²⁶ was developed to assess awakenings and has been recommended by the Federal Interagency Committee on Aviation Noise (FICAN). This was developed from assimilating various sleep interference tests and considers the SEL values of individual events and the volume (quantity) of events. There has been considerable discussion about awakening evaluation because it is evident that many people in an aircraft noise-affected community significantly acclimate to the noise environment. Thus, those new to an aircraft noise environment are more likely awakened than those who have resided in the area for a substantial period. This is still a new area of study in regard to sound insulation. One program at an airport that serves as a hub for an express package service with nighttime operations allowed treatments in bedrooms that provided greater NLR to create a better sleeping environment. This was not part of a Part 150 program but rather part of a mitigation agreement based on an EIS for the addition of new nighttime flights.

²³ U.S. Department of Transportation, FAA, AC 150/5020-1, Noise Control and Compatibility Planning for Airports, August 5, 1983.

²⁴ David A. Bies and Colin H. Hansen, *Engineering Noise Control, Theory and Practice*, 3rd ed., Spoon Press, 2003, pp. 150–151.

²⁵ ANSI, ANSI S 3.5, American National Standard Methods for Calculation of the Speech Intelligibility Index.

²⁶ ANSI, ANSI S 12.9, Quantities and Procedures for Description and Measurement of Environmental Sound – Part 6: Methods for Estimation of Awakenings Associated with Aircraft Noise Events Heard in Homes.

4.6 Acoustical Testing

The program objectives are to meet the interior $DNL \leq 45$ dB and $\Delta NLR \geq 5$ dB on the basis of the design year NEM (which, per PGL 05-04, must be currently valid). PGL 12-09 goes on to clarify this requirement:

In general, NEMs less than 5 years old are considered current unless conditions have created a significant change that would affect noise contours. NEMs older than 5 years old must be certified by the sponsor and updated as required as discussed in the PGL.²⁷

Therefore, the aircraft noise environment used for acoustical design and for acoustical testing of NLR should consider the aircraft fleet mix, flight tracks, and so forth for all flight operations from the NEM. An ideal acoustical test program for pre- and post-retrofit would accomplish the following for each structure tested:

- Consider only aircraft noise, ignoring all other noise sources.
- Integrate the sound spectra from all aircraft used in the NEM.
- Integrate the flight tracks by aircraft type from all aircraft used in the NEM.
- Integrate the sound incidence angles of all aircraft on all flight tracks, by aircraft type, from all aircraft used in the NEM.
- Integrate the change in meteorological conditions with all other parameters used in the NEM.

The only way all of these goals can be accomplished would be through continuous attended noise monitoring and simultaneous monitoring inside and outside each residence for the NEM scenario, while manually deleting non-aircraft acoustic events. Since this is infeasible, testing methods that allow for data generation that can be further analyzed by computer models are a benefit for an acoustical testing program.

Two methods have been most commonly used in SIPs for field testing the TL of rooms within a structure: the aircraft flyover test and the artificial noise source test. A third method has also been employed: the indoor-outdoor speaker test. Each method has technical and logistical advantages and disadvantages.

It should be noted that PGL 12-09 states, “Long standing agency policy is that an airport sponsor must use the 1992 guidance to establish the existing interior noise levels to determine whether or not the building qualifies for sound insulation using AIP.” Since the 1992 guidelines mention only overflight as a testing methodology, SIP sponsors and consultants have requested that the FAA clarify if the PGL is intended to preclude testing using artificial noise. **Sponsors are advised to consult with their local ADOs for direction on allowable means and methods of testing.**

The most valid and precise acoustical testing for sound TL is laboratory testing of building systems and materials;²⁸ field testing procedures²⁹ are designed to parallel lab procedures as much as is practicable. Laboratory testing is performed by inserting the window, door, or other building element into an opening between two large rooms in the testing facility, then generating a diffuse sound field on the source room side, recording the spatial average diffuse sound level in each room, and subtracting the receiver room noise level from the source room noise level to obtain the NLR. A small correction is then applied to account for the noise buildup and absorption effects of the receiving room. The diffuse sound field has sound waves traveling in all directions with equal probability. This is necessary because the incidence angle at which sound impinges on a material affects its TL properties. However, it is clearly impossible to field test existing buildings

²⁷ See note 3.

²⁸ ASTM, ASTM E90, Test Method for Laboratory Measurement of Airborne-Sound Transmission Loss of Partitions.

²⁹ ASTM, ASTM E966, Guide for Field Measurement of Airborne Sound Insulation of Building Façades and Façade Elements.

using this laboratory-based method, even though an interior room approximates one room with a diffuse sound field. The sound field outside the structure constitutes both a free field, not influenced by local sound reflection, and a far field, not close to or influenced by the noise source size.

PGL 12-09 specifies several testing procedures and protocols for AIP-funded programs.

- Interior noise testing is to be conducted with windows and doors closed. This protocol applies without regard to the presence of ventilation systems.³⁰
- The measurement of interior noise levels is an average for all habitable spaces in a particular residential unit.³¹
- FAA-accepted guidance on testing frequency, sampling, and other statistical measures is contained in the *Guidelines for Sound Insulation of Residences Exposed to Aircraft Operations*, prepared for the Department of the Navy by Wyle Laboratories in 1992.³²
- The ADO must approve or disapprove a sponsor request for reimbursement for testing more than 10%, but not more than 30%, of the residences of a particular construction type.³³
- For requests for reimbursement for more than 30% of the residences of a particular type, the ADO must receive APP-400 approval.³⁴
- Occasionally residents may request that their residence be tested specifically. This may be because of the condition of the home or because the resident believes that the residence will test differently than others. These additional tests are generally allowable. However, if an additional residence is tested, it must be tested both before and after any noise insulation work to ensure that the 5-dB NLR is achieved.³⁵

4.6.1 Aircraft Flyover Method

The aircraft flyover test is used throughout sound insulation programs. This method simultaneously measures the exterior free-field incident sound of flyovers and the diffuse sound field in the test room inside the structure. The difference in the two A-weighted sound exposure levels (SEL values) is subtracted to yield the NLR of the room. In practice, synchronized digital programmable sound level meters are positioned in the free field outside the home and in the room. They simultaneously record multiple events, allowing for computation of the NLR for each event and statistics for a series of flyover events. Typically, two interior rooms are measured simultaneously. These measurements generally follow a national standard for field TL measurement.³⁶

The flyover method is assumed to provide a reasonable approximation of the TL in each room, but does have the following limitations and sources of error:

- The sound spectra of the aircraft flyover samples are assumed to be the average for all aircraft used in the NEM. This is unlikely since measurement on a single day will likely record aircraft during a single operation type (i.e., all landings or all takeoffs) and not reflect that of the annual mix. This method is best used at an active airport with a high number of daily operations.
- Extraneous noise sources for occupant or neighborhood activity are recorded and may be included with the aircraft noise measurements. These sources include occupants, local vehicles, construction, recreation, and other neighborhood activities.

³⁰ U.S. DOT, FAA, PGL 12-09, August 17, 2012, Attachment 1, §812 (c)(1), Table 1, p. 1-4.

³¹ U.S. DOT, FAA, PGL 12-09, August 17, 2012, Attachment 1, §812 (c)(1), Table 1, p. 1-3.

³² This document may be found on the FAA Airport Noise website at http://www.faa.gov/airports/resources/advisory_circulars/index.cfm/go/document.information/documentNumber/150_5000-9A.

³³ See note 15.

³⁴ See note 15.

³⁵ U.S. DOT, FAA, PGL 12-09, August 17, 2012, Attachment 1, §812 (c)(2), Table 2, p. 1-8.

³⁶ See note 29.

- A single stationary microphone in a room does not give a good measure of the diffuse sound field. Laboratory tests use large rooms of special dimensions, often with moving microphones or vanes, and nonparallel walls to minimize standing wave effects. Microphones in small rooms are significantly influenced by location, particularly with pre-retrofit testing where the location relative to a poor sound-attenuating window may have considerable effect. It is difficult to obtain a satisfactory reverberant field in a small room.
- The total NLR is primarily from the composite transmission loss characteristics of the structure but also from the room acoustics controlled by the size and absorptive properties of the receiving room. Therefore, if there is a considerable change in room furnishing between the pre- and post-retrofit testing, a significant change in room absorption will affect the measured NLR.
- Different aircraft under different operating conditions are recorded for the pre-construction and post-construction acoustical measurements. These different operating conditions result in different spectra and incidence, therefore posing another source of error.

4.6.2 Artificial Noise Source Method

The testing method using a generated noise source is similar to the flyover test method and is also used throughout sound insulation programs. As with the flyover method, this method simultaneously measures the exterior free-field incident sound of flyovers and the diffuse sound field in the test room inside the structure. The difference in the two sound exposure levels (SEL values) is subtracted to yield the NLR of the room.

This method uses an artificial aircraft sound source (loudspeaker), usually mounted on a telescoped boom from a truck and elevated to a position to approximate the incident angle of aircraft. However, the physical limitations for employing a boom truck may require that the loudspeaker simply be mounted on a tripod set at ground level. Free-field exterior and diffuse interior measurements are made by consultants who often record the noise to allow for spectral measurement. These measurements may also identify flanking paths and may use near-field measurements to identify the approximate TL of individual building elements. The interior microphone is circulated throughout the room by a consultant during the measurement to optimize reverberant field measurement. Typically, two interior rooms are measured sequentially. These measurements generally follow a national standard for field TL measurement.³⁷ The artificial noise source method is assumed to provide a reasonable approximation of the TL in each room but does have the following limitations and sources of error:

- The sound spectrum of the artificial noise source is assumed to be the annual energy average for all aircraft used in the NEM. This is unlikely since measurement on a single day will likely not reflect that of the mix of airplanes recorded in the NEM.
- The free-field coverage of the loudspeaker over the structure is assumed to approximate that for all aircraft used in the NEM. In practice, loudspeaker coverage is considerably inferior to that from aircraft.
- The sound incidence of the loudspeaker noise is assumed to be the average for all aircraft used in the NEM. This is unlikely since measurement on a single day will likely not reflect that of the annual mix. Angle of incidence is important since normal incidence (perpendicular to the surface) may provide as much as 5 dB more attenuation than tangential incidence (parallel to the surface) due to incitement of flexural waves.
- The total NLR is primarily from the composite transmission loss characteristics of the structure but is also from the room acoustics controlled by the size and absorptive proper-

³⁷ See note 29.

ties of the receiving room. Therefore, if there is a considerable change in room furnishing between the pre- and post-retrofit testing, a significant change in room absorption will affect the measured NLR.

4.6.3 The Indoor–Outdoor Speaker Method

The indoor–outdoor method has been used only a relatively short time, and as of the publication of these guidelines, does not have the endorsement of the FAA. It is currently used by a single acoustical consulting firm, and only general information about the procedure has been made publicly available. This method reverses the location of the sound source and receiver from that of the aircraft and speaker methods; that is, the interior room is the sound source room and the exterior is the receiving area. A calibrated sound source is generated within the room to be tested generating a diffuse sound field, and the receiver noise levels are measured in near-field areas immediately outside of the structure. Since the structure is composed of building elements with varying TL performance (particularly for the pre-retrofit structure), it is necessary to measure the near field of various building components over all exterior façades, measure the area of each, and compute the composite transmission loss of the structure. Currently no national or international standards for the procedure have been promulgated.

4.6.4 Comparison of Acoustical Test Methods

As noted previously, each method has significant advantages and drawbacks. The flyover method has the logistical advantage of not requiring anyone present during the measurement. The artificial noise source method has the advantage of only requiring a single meter transferred between the two rooms; also, the measurement may be conducted in less time unless setup with the bucket truck is complicated. More important are the sources of error and unreliability associated with each method. These are summarized in Table 4.2.

It is difficult to determine a best test method. Each has significant benefits and limitations. The decision of which method the acoustical consultant selects is influenced by logistical and technical factors. Some SIP work is for future flight operations, making any flyover measurement program impossible. Many other locations are difficult to traverse and have many trees and utility wires, making it impossible to employ a crane or bucket truck for the artificial noise source methods. There appears to be no strong consensus among acoustical consultants on a preferred

Table 4.2. Comparison of acoustical test methods.

	Flyover	Artificial Noise Source
Diffuse sound source	Yes	Marginal
Repeatable measurement	No	Yes
Adverse room acoustic effects	Yes	Minimal
Statistical results	Yes	No
Elimination of bad results	Some	Yes
ID of weak building elements	No	Yes
Flanking measurement	Marginal	Yes

Courtesy of Freytag & Associates.

test method or which provides the most accurate and reliable results. However, most consultants appear to agree on the following limitations and benefits of the two common methods:

- It is advantageous to have flyovers for the sound source since they provide the most realistic acoustical environment for testing. It is also advantageous to have statistical results since these at least minimize random errors, though not consistent errors such as those from room acoustic effects.
- The attended measurements for the artificial noise source method allow use of a moving microphone in the receiving room, significantly reducing room acoustic effects. This attended method also prevents contamination from extraneous noise events and allows for collection of approximate NLR information on individual building elements.

Measurements of noise levels in field situations are subject to many variables, including the type and accuracy of instrumentation, the source of test noise (whether it be aircraft flyovers or loudspeaker), the shape and size of the interior room, and the type of furnishings in the room. ASTM E966-04, Standard Guide for Field Measurements of Airborne Sound Attenuation of Building Façades and Façade Elements, recognizes these uncertainties with the following statement regarding measurement precision:

No body of experience in the use of this guide exists at present; however, it is estimated that the repeatability standard deviation of the test procedure is of the order of 2 to 4 dB, depending on frequency.

That is, a number of teams of operators testing the same field situation using this procedure would produce a population of test results whose scatter about the arithmetic mean would correspond to a standard deviation of 2 dB to 4 dB. Even taking the smaller of these figures, a standard deviation of 2 dB, this means that there is a 16% chance (almost 1 in 6) that the real noise reduction is at least 2 dB less than the measured value. To be confident that eligibility is determined fairly and equitably, a 3-dB allowance should be introduced to account for these uncertainties.

No studies have been identified that provide comprehensive statistical assessment of the accuracy and reliability of the two common methods. Such a study would comprise comparative testing for the two methods on the same structures and an analytic CTL computation (see Section 4.2.4). The results of such a study would quantify the accuracy and repeatability of the two methods in terms of confidence interval and probability level (e.g., a confidence interval of ± 2 dB @ 95% certainty level).





This margin of error is a potential issue since it affects program eligibility. Some homeowners may challenge the eligibility testing, necessitating a testing methodology that is beyond dispute or a margin of error for the measurements. However, the FAA has not addressed the issue of margin of error in measurements. Table 4.3 shows the potential effect on program eligibility from the perspective of a ± 3 -dB margin. One method to address the margin of error is available in the 1992 guidelines, which state, “The exterior levels are taken from mapped DNL contours which show current DNL levels in 5-dB increments. In determining the required noise reduction, the higher end of the noise zone range is always used.”³⁸ This procedure could adjust for some of the margin of error that is possible when using 1-dB contour increments.

The FAA’s 1992 AC 150-5000-9A, page 3-18, states that “the exterior levels are taken from mapped DNL contours which show current DNL levels in 5 dB increments. In determining the required noise reduction, the higher end of the noise zone range is always used.” The PGL does not mention the increments of the contour needed to use in calculating interior noise levels. Sponsors and consultants have requested that the FAA clarify whether the recommendation of using the higher end of the 5-dB contour still applies.

³⁸ See note 18.

Table 4.3. Margin of error effects in eligibility testing.**MEASURED DNL VALUES**

TRUE DNL _{in}	MEASUREMENT ERROR						
	-3	-2	-1	0	+1	+2	+3
42	39	40	41	42	43	44	45
43	40	41	42	43	44	45	46
44	41	42	43	44	45	46	47
45	42	43	44	45	46	47	48
46	43	44	45	46	47	48	49
47	44	45	46	47	48	49	50
48	45	46	47	48	49	50	51

 Correctly eligible — True positive (lower right)
 Incorrectly eligible — False positive (upper right)
 Correctly ineligible — True negative (upper left)
 Incorrectly ineligible — False negative (lower left)

Courtesy of Freytag & Associates.

4.7 Best Practice Recommendations: Acoustical Engineering

1. Assist the project team at the outset of the program by participating in the public outreach program to explain program approach, FAA policy and guidelines, homeowner responsibilities, and expectations from the retrofit treatment.
2. The acoustical design criterion used in the majority of programs is to achieve a uniform level of noise reduction for the entire building envelope. Focus on the major rooms of the house with normal to significant exterior exposure and let the consistent envelope treatment apply to rooms with smaller amounts of noise exposure to avoid over- and under-design of habitable rooms.
3. Provide technical input for policy decisions regarding what expenses the program may incur to go above uniform treatments, whether to treat residences where some but not all rooms currently meet an interior DNL of 45 dB, and how to account for measurement tolerances.
4. Design a pre- and post-construction measurement program to efficiently measure the difference in NLR and provide a reasonable estimate for the accuracy and reliability of measurement results.
5. To ensure that FAA eligibility requirements and acoustical criteria are met, determine existing interior noise levels for each residence and design treatment protocols using acoustical modeling. Continuously calibrate the TL values used in the modeling process by field testing typical and diverse housing conditions. Consult with the SIP's FAA point of contact regarding any eligibility questions.
6. Consult with building material and building system vendors to review new products for use on the SIPs. Assist with material inspections in cases of new, unusual, or questionable products or materials.



CHAPTER 5

Design of Architectural Treatment Strategies

All airport SIPs share a common goal of providing homeowners, students, and worshippers quiet environments in which to carry out activities without disruption from aircraft noise. Geographic diversity, wide-ranging climatic conditions, local construction practices, and building codes dictate acoustical and architectural applications that are appropriate to particular communities. Programs across the country tailor their sound insulation treatments to meet unique local conditions as well as the end user's needs for user-friendly, architecturally appropriate, historically correct, and acoustically effective products.

Finding the right combination of appropriate treatments that provide acoustical performance, building owner satisfaction, operational ease, reasonable cost, appropriate lead times for fabrication and delivery, extended warranty, and customer service is critical in delivering a successful sound insulation program.

Sound insulation treatments are designed to reduce noise entering into interior space through the exterior building envelope. Since windows and doors can account for the majority of unwanted noise entering a standard structure, SIPs have focused their efforts on creating better barriers for these major noise paths while being mindful of ancillary noise paths. Effective collaboration between program managers, designers, and manufacturers of acoustical products has resulted in a variety of architectural solutions.

5.1 Treatment Goals

As explained in Chapter 4, the FAA has set two measureable goals to prove the efficacy of sound insulation. They are that the post-treatment interior noise level is equal to or less than 45-dB DNL and that the treatments have achieved at least 5 dB of NLR. To meet these goals, the design effort needs to establish what the existing noise-reducing performance is of the building being treated and to what noise level it is exposed. This information can be obtained either through testing every building to be treated or undertaking an effort to establish statistical performance based on construction typologies. Residential neighborhoods with standard construction typologies are suited to a statistical understanding of performance. Public institutional buildings tend to be unique and require individualized testing and design. Once a performance objective is established, the design effort can begin. This chapter presumes that a building has met qualifying thresholds of noise exposure discussed in Chapters 2 and 4 and is eligible for treatment.

In addition to measurable acoustic goals, successful programs set a goal to establish good relationships with the community served by the program. Many aspects of community outreach are discussed in Chapter 3. However, there are aspects of treatment design that contribute to meeting the goal of community satisfaction. These include choosing products that are of good quality,

Table 5.1. Average NLR increase across many programs.

Region	NLR		
	Pre-Test	Post-Test	Increase
Northern	27.2	34.1	6.9
Western	25.2	32.2	7.0
Southern	23.9	32.8	8.9

that are long lasting, and that perform well; designing treatments that maintain the aesthetic characteristics of the neighborhood as much as possible; and detailing treatment installations to reduce disruption to occupants during construction. Defining these aspects for each program can be informed by programs and practices at airports across the country, but the final determination of what is appropriate is a local decision.

5.1.1 Determining Treatment Needs

Exterior noise levels ranging from 65-dB DNL to upwards of 75-dB DNL affect buildings treated for sound insulation. The majority of airports have reduced their highest noise contours to the extent that most residences are not exposed to noise above 70-dB DNL; however, some larger airports still have noncompatible structures in high noise contours. It is important in determining treatment requirements to know the NLR of an existing building and the exterior noise exposure level in which it is located. The mathematical difference between the two determines the noise level reduction needed to bring the building into compliance with the goal of having interior exposure at or below 45-dB DNL. While 5-dB NLR is the minimum reduction to achieve, some buildings will require more due to their exterior exposure level or deficient pre-existing construction. Coordinate this with the acoustical consultant as part of the early design process.

Noise contours are determined in 5-dB increments (e.g., 65 dB to 70 dB and 70 dB to 75 dB). The 2005 guidelines state, “In determining the required noise reduction, the higher end of the noise zone range is always used.”¹ So exposure within the 65-dB to 70-dB DNL is regarded as exposure to 70-dB DNL. This accommodates rounding and statistical margins of error in measurements.

Noise contour	70 dB DNL	70 dB
NLR required to reach ≤45 dB	25 dB	25 dB
Pre-existing NLR	19 dB	21 dB
Treatment goal	6 dB	5 dB (program minimum)

Table 5.1 shows the successful average NLR achieved by sound insulating programs as verified in post-construction testing of approximately 4,000 homes. These data span many programs and years.

5.1.2 Understanding Building Code Regulations

Program treatments must be designed and constructed in accordance with prevailing building codes. While a single national building code based on the IBC is slowly emerging, each state, and

¹Department of the Navy, Naval Facilities Engineering Command, *Guidelines for the Sound Insulation of Residences Exposed to Aircraft Operations*, as referenced in FAA AC 150/5000-9A, April 2005. pp. 3–18.

sometimes municipality, may adopt variations in its requirements for construction. Additionally, each jurisdiction may have adopted different editions or appendices of the IBC, which is updated every 3 years. In code parlance, the work of sound insulation programs is “alteration” rather than “new construction.” There are three levels of alteration, each with increasing requirements based on the extent and value of work. Questions may arise as to whether a building permit is even needed. That determination is strictly a local issue, and a ruling will be required from each jurisdiction affected by the SIP. In some jurisdictions, homeowners may be able to self-perform alterations to their homes without a building permit; however, in most jurisdictions the replacement of HVAC systems and the use of licensed contractors, design professionals, and federal funds necessitates the issuance of building permits. The codes for residential and institutional buildings differ greatly, and programs will need to understand these differences if working on both types of properties.

An important program start-up activity is to meet with the local building official(s) and present the program protocols. It is a best practice recommendation to go to that meeting with a code, zoning, and permitting review already completed, accompanied by a prepared interpretation of the requirements that will affect the SIP. If the program spans multiple jurisdictions, the building officials from each jurisdiction will need to be consulted. If there is a difference in code interpretation between jurisdictions, a program may want to adopt the strictest interpretation for all of their treatments to avoid confusion among homeowners, designers, and contractors.

Building codes are revised regularly and often in response to situations that have become apparent through experience. Most of the buildings treated by sound insulation programs are older and built under codes that have since been superseded. Safety is the first consideration of building officials, so while a structure may be able to persist in its present or grandfathered condition, the action of pulling a construction permit may present an opportunity for officials to correct issues they deem to be of importance for life safety. This can lead to resizing of windows, doors, or mechanical systems, or prevent ceiling treatments that would lower an already non-conforming ceiling height. Programs use the phrase “like for like” to indicate that treatments replace existing conditions and do not constitute a renovation project. Where necessary, programs may need to enlarge windows or doors for emergency egress, build safer landings at entrances, or increase electrical services and air ducts for ventilation systems in order to offer the treatments while meeting the requirements of the authority having jurisdiction.

The U.S. Department of Energy (U.S. DOE) requires buildings to be energy efficient, and many state and local jurisdictions have adopted energy conservation codes. These could include thermal performance, like U-value or solar heat gain, that restricts the use of some types of windows or glass. Further discussion of energy issues is contained in Chapters 7 and 8.

5.1.3 Best Practice Recommendations: Treatment Goals

1. Meet with the local building official(s) and present the program protocols; go to that meeting with a code, zoning, and permitting review already completed, accompanied by a prepared interpretation of the requirements that will affect the SIP.
2. If the SIP spans multiple municipalities and there is a difference in code interpretation between jurisdictions, a program may want to adopt the strictest interpretation for all of its treatments to avoid confusion among homeowners, designers, and contractors.
3. Determine a method for identifying noise exposure and pre-existing NLR to calculate treatment goals.

5.2 Residential Sound Insulation Treatments

The majority of houses in the United States are built using defined standards and materials. Standard residential construction is made up of dimensional wood lumber or masonry units. There are always exceptions, but most programs do not encounter log homes, geodesic domes, traditional adobe, tensile fabric structures, and so forth. When exceptions occur, specialized attention to treatability and eligibility will require professional evaluation, which is outside the realm of these guidelines. Mobile (manufactured)² homes are not considered standard residential construction and are not eligible for sound insulation. Modular construction required to meet the standards for the IBC is considered standard construction and is eligible for sound insulation. Details for installing the acoustical treatments may need modification to account for differences in the modular construction.

PGL 12-09 states, “Some permanent modular structures may be classified as permanent if they meet construction guidelines applied to permanent structures.”³ Building codes have specific regulations governing the construction of modular structures. As such, permanent modular structures may be treatable if they conform to the applicable building codes governing their construction.

5.2.1 Windshield Surveys

If a thorough inventory of the housing stock is not part of the Part 150 noise compatibility study, one should be undertaken to catalog the eligible buildings in the contour. Using available municipal GIS data as a base, drive past every property (thus the title “windshield survey”) with the goal of gathering preliminary information on the housing stock and its condition. It is not uncommon to discover discrepancies between public records data and actual conditions at the sites.

The data gathered will help identify the housing typologies that inform initial treatment protocols and concepts of neighborhood treatment standards. Establishing typologies also helps generate program policies that can be applied across multiple residences and allows for the formation of an approach for choosing homes in pilot studies. Testing each typology provides data that validate and calibrate acoustical modeling for individual homes. These data will direct the design team toward creation of acoustical treatments and selection of appropriate products for the types of houses to be treated.

The goals of the windshield survey are to:

- Verify the number of residential units within the noise impact area.
- Catalog residential housing types in addition to vacant lots, apartments with multiple units, mixed-use commercial, and residential properties found throughout the neighborhoods.
- Photograph all housing to correlate with county property records.
- Collect data for categorizing all of the properties by type, style, construction, and construction date.
- Determine, based on view from the street, if the structure is in good, fair, or poor condition. Condition of the residences generally correlates to ease of construction and potential for issues that can delay participation in the program.
- Inform the development of policies and procedures and treatment recommendations to meet neighborhood standards.

² See Section 2.1.4, Items to Consider Prior to Program Start-Up, Subsection A, Types and Number of Structures, for definitions of modular and manufactured homes.

³ U.S. DOT, FAA, PGL 12-09, August 17, 2012, Attachment 1, §812 (c)(3), Table 3, p. 1-10.

- Establish if any houses might need a review for historic significance.
- Document visible code or safety concerns, such as bedroom windows that are too small or high off the ground to meet current building code standards for emergency egress and fire access.
- Identify unique conditions that may be visible to establish potential custom treatments that may affect program policies.
- Establish style typology. Since the style of the house can indicate acoustical treatment response, the windshield survey records information about the various styles in treatment-eligible areas.

5.2.2 Housing Typologies

The form, materials, and construction of a building's exterior envelope can have an impact on acoustical treatment strategies. In addition to material and construction, the styles of houses can result in noise paths that program consultants need to be aware of. All of the following styles and houses have participated in SIPs.

A. Cape

Cape-style houses (see Figure 5.1) are prevalent in the eastern and middle United States and were a popular housing type in the post-WWII suburban expansion. The impact to acoustical treatment for this style is the presence of living space directly under the roof without the benefit of buffering from attic space. The roof is also low and proximate to head height in upper floor rooms. Due to the location of these rooms directly below the roof structure, additional mass or insulation may need to be added to mitigate noise paths through walls or ceilings if no barrier materials currently exist. The existing knee walls should have a continuous, minimum ½-in. gypsum wall board (GWB) or equivalent interior finish. The existing inclined and horizontal ceilings should have a continuous, minimum ½-in. GWB or equivalent interior finish. For upper-level living spaces where barrier materials exist at knee walls and ceilings and where there is access to spaces behind knee walls and above ceilings, insulation should be installed at the back side of the wall and/or above ceilings. Doors or access panels to an attic space need to be replaced with a fully weather-stripped interior solid core door if the existing door does not meet acoustical guidelines. Undersized bedroom windows may need to be enlarged for emergency egress.



Figure 5.1. Cape-style houses.

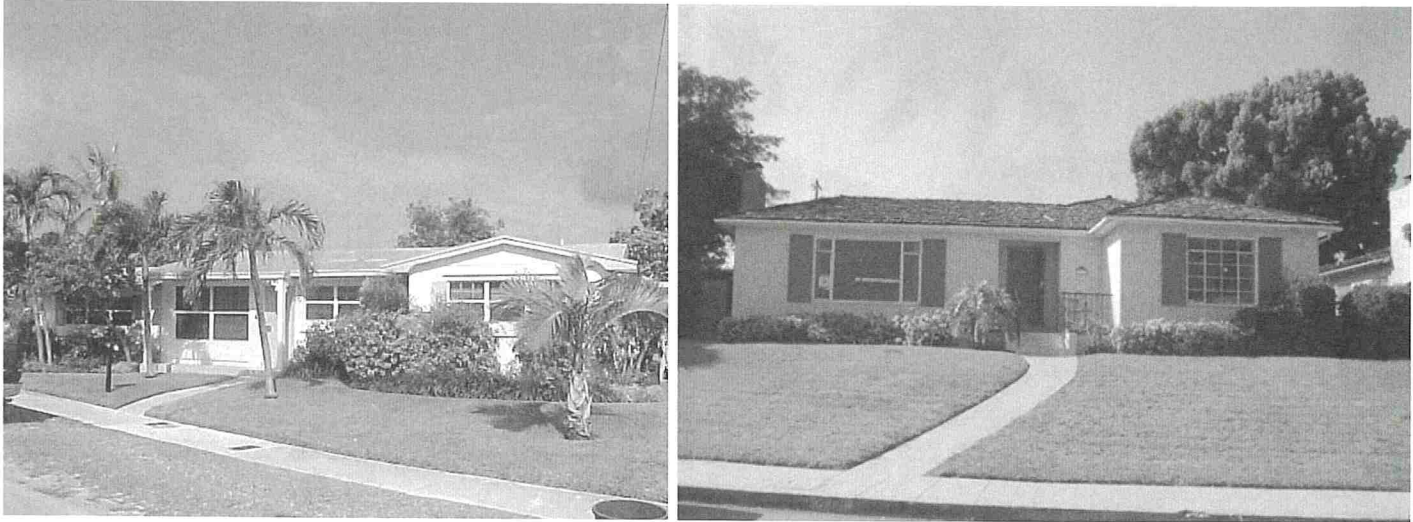


Figure 5.2. *Ranch houses.*

B. Ranch

The ranch (see Figure 5.2) is a common style that uses siding, stucco, or brick. Many contemporary ranch houses are on slab foundations, thereby eliminating any acoustic exposure through crawl spaces located under floors. The majority have shallow-pitched gable or hip roofs with small attics beneath. Small attics can create design challenges for locations of air conditioning or ventilation systems. Openings into the attics from the interior will require treatment for reduction of noise though pull-down stairs or attic hatches. There is some possibility for cathedral ceilings. Acoustic exposure will need to be evaluated by testing to determine if treatment to any ceilings will be needed. Many ranch houses have picture windows in the front, and some may be configured with bay/bow windows. Replacement of bay/bow windows with a similar acoustic style is generally not possible. Alternately, an interior storm window mounted flush with the interior wall surface can be installed on the existing bay/bow window unit. Window configurations will be dependent on sizes available from manufacturers.

C. Raised or Split Ranch

The raised or split ranch style includes two-story single-family homes where it is possible that framing will differ between floors. The photos in Figure 5.3 show raised ranch style houses with a hip roof. These houses appear to be frame construction on the second floor and block construction on the first floor. One of the design considerations in mixed framing is that the installation details in the house will vary depending on the wall thicknesses and exterior siding. Split-level ranches involve level changes in the house and often have multiple levels of roof. Exposure to noise may be through walls that are exposed to roof noise.

D. A-Frame Contemporary

The A-frame contemporary style (see Figure 5.4) is dominated by the roof and has large sections of custom glazing. Shown on the right is a coastal A-frame with hurricane protection panels over trapezoidal glass sections. The roof, the glass, and the volume of space to be treated require thoughtful acoustical, HVAC, and architectural design.

E. The Row House and Triple-Decker

The row house and triple-decker (see Figure 5.5) styles have in common that they are single-family dwellings in a multifamily setting. A triple-decker is three units stacked vertically. The



Figure 5.3. Raised or split ranch houses.



Figure 5.4. A-frame contemporary style houses.

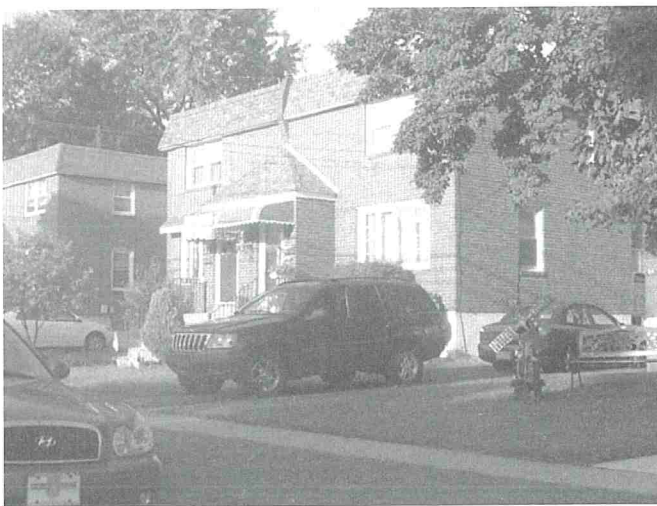


Figure 5.5. The row house and triple-decker.

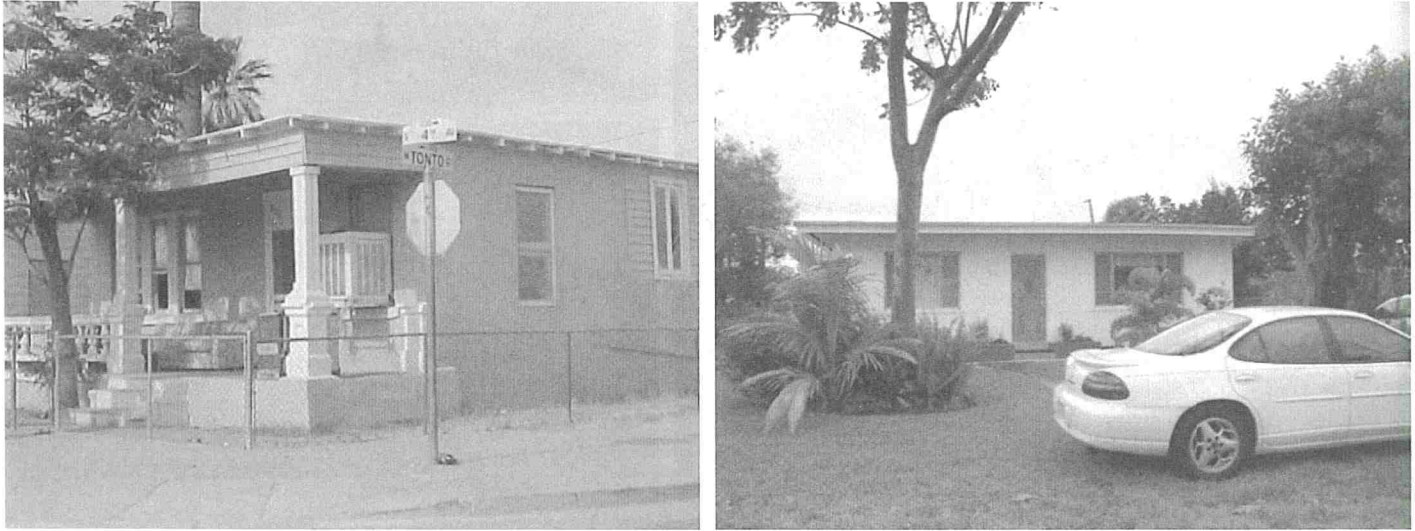


Figure 5.6. *Beach bungalows.*

uppermost unit is often under a flat roof with exposure to overflight noise. If the structure has been made into condominiums, issues may arise about exterior consistency of design for treatments, depending on each owner. Row houses are similar except horizontally stacked. Issues of exterior consistency need to be negotiated before design proceeds.

F. Beach Bungalow

As opposed to arts and crafts style bungalows, which can be very detailed and historic, the beach bungalow (see Figure 5.6) is a minimalist box with a flat roof. The flat roof is often low and is a direct noise path potentially requiring treatment.

G. Historic Homes

Historic homes (see Figure 5.7) come in many styles across the country and are discussed in Chapter 6. Issues may include custom window and door shapes, intricate detailing for product installation, and design restrictions due to historically significant characteristics.

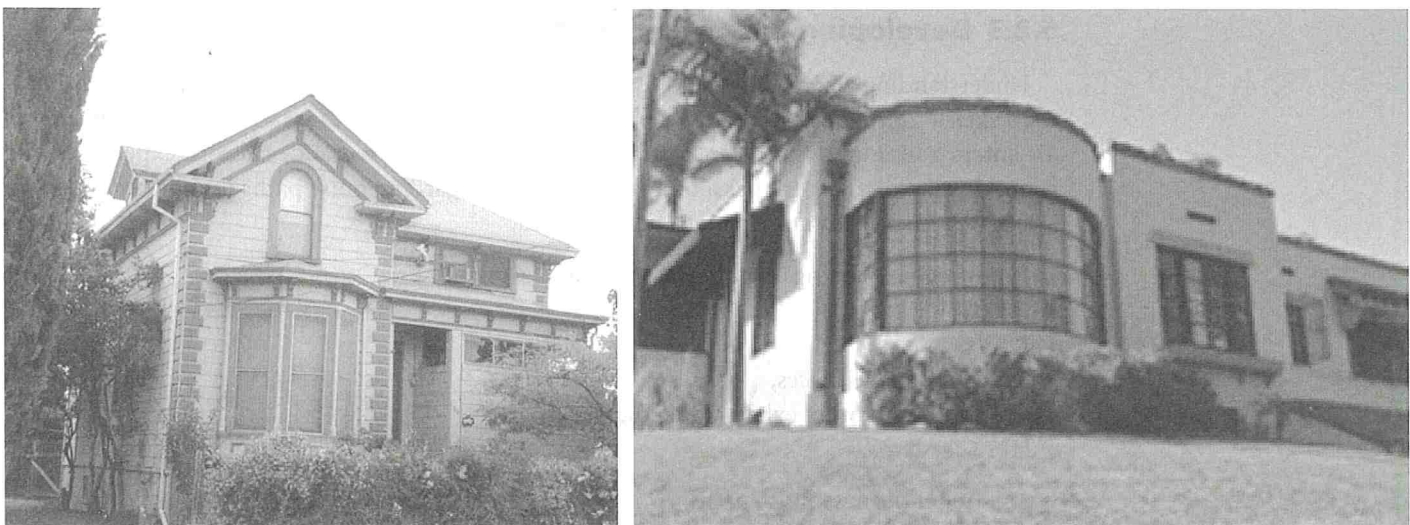


Figure 5.7. *Historic homes.*

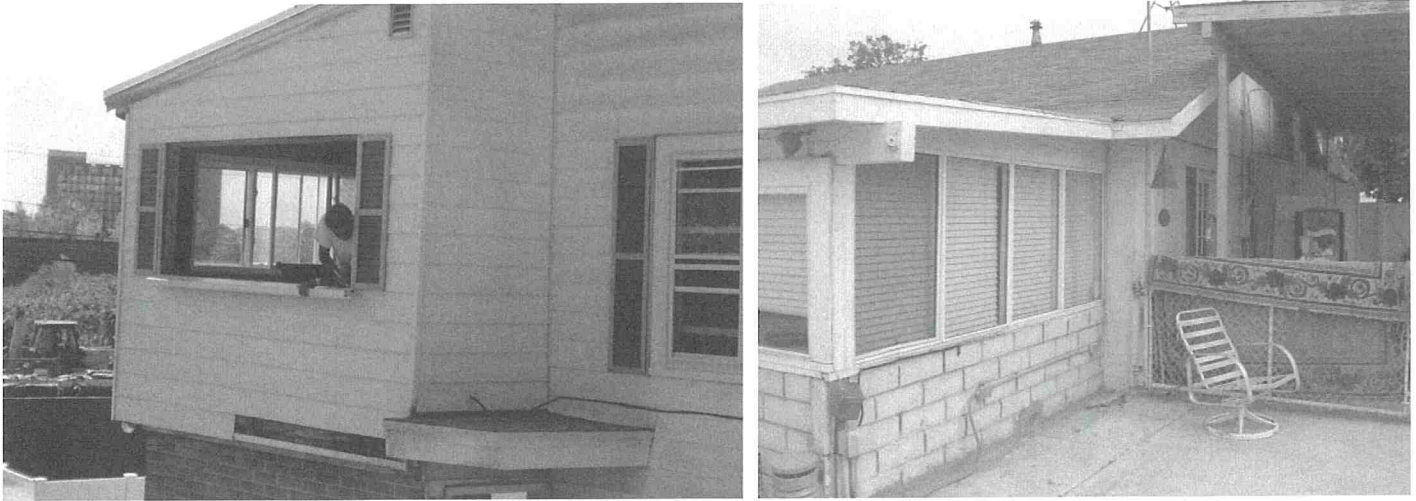


Figure 5.8. Additions.

H. Additions

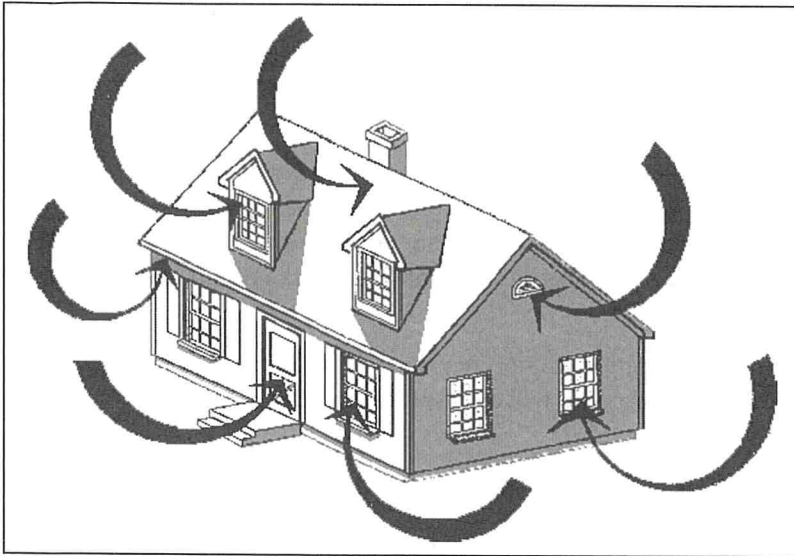
While not a style, additions to houses (see Figure 5.8) require special attention for noise paths. Additions can be built of lighter-weight construction than the rest of the house. Closer inspection of the houses during assessment will help determine whether any exterior walls or ceilings consist of a less-than-normal assembly of materials and whether more in-depth structural inspections will be necessary. It is also cautioned to review building permit records to see if additions were inspected. Unpermitted additions may require additional coordination with the local building department for the program to pull permits for the sound treatments. These types of enclosed spaces will be evaluated to determine if they meet the criteria for year-round habitability, including adequate and permanent HVAC; construction materials and assemblies that meet standard building practices; and foundation, wall, ceiling, and roof assemblies that meet code requirements. Where additions do not meet standards for year-round habitability, evaluate noise paths into the main structure for treatment. Finally, it is important to verify that any area of the house that is being considered for sound insulation meets the best practice recommendations discussed in Section 5.2.7.

5.2.3 Developing Treatment Strategy

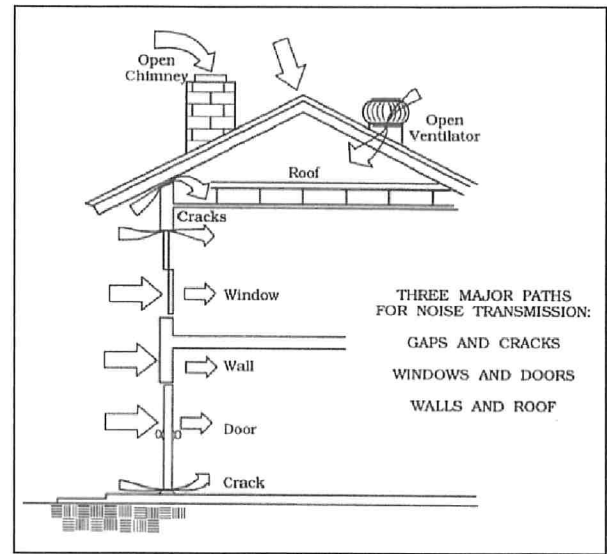
Understanding where aircraft noise intrudes into a building means understanding the building's exterior envelope (see Figure 5.9). From the foundation to the walls to the roof, wherever air enters a building, noise can be transmitted. Thanks to several decades of experience, the sound insulation industry has a body of knowledge regarding noise paths into most residential structures. Sources of noise penetration include:

- Fenestration openings (windows, doors, and skylights),
- Walls,
- Roofs,
- Attics and crawl spaces,
- Chimneys and other exhaust openings, and
- HVAC systems.

Treatment of these noise paths involves two primary methods. The first involves dissipation, which reduces the noise energy through baffles and turns in ductwork. Where air flow cannot be eliminated, such as in mechanical systems and attics, noise energy dissipation through baffles



Courtesy the Jones Payne Group, Inc.



Courtesy Wyle Laboratories, Inc.

Figure 5.9. Noise paths.

and ductwork works well. The second treatment method involves providing physical barriers to noise, usually in the sequence of (1) mass, (2) air space, and (3) mass. This applies to many building assemblies, such as walls, roofs, and glazed systems. Glazed openings are treated using this sequence to reduce noise without making products that are too heavy. Mass is provided by glass that is thicker than standard materials (e.g., laminated glass) on either side of approximately 1 in. to 2 in. of trapped air space (e.g., between insulating glass). More information on fenestration products is available in Chapter 9.

It is important in the pilot phase of a program to include treatment protocols for treating noise paths other than windows, doors, and HVAC systems. Until the first structures are assessed, impacts from those paths may not be discernible. Per PGL 12-09, authorization to treat such noise paths must be secured in advance, making it imperative that treatment designs are included in the initial submission of the program policy and procedure manual to the ADO:

Noise insulation measures are limited to window and door replacement, ceiling insulation, caulking, weather stripping, and central air ventilation systems.

The use of other measures is not allowable unless the ADO has approved the use of the measures in advance.⁴

Treating windows and doors addresses the major source of noise into most homes. There are three principal ways to treat fenestration openings:

1. Repair and upgrade existing windows and doors with new glass, weather stripping, caulking, and so forth.
2. Add secondary storm products to the existing openings.
3. Replace the product with acoustically rated products.

PGL 12-09 limits noise insulation measures to “specific items.”⁵ Except for ceiling insulation, wall and ceiling treatments are not included in the list of treatments cited. If achieving a 5-dB reduction is an absolute, then in some instances, wall and ceiling treatments will be required. The PGL allows for these as “other measures,” subject to approval in advance by the

⁴U.S. DOT, FAA, PGL 12-09, August 17, 2012. Attachment 1, §812 (c)(1), Table 1, p. 1-4.

⁵U.S. DOT, FAA, PGL 12-09, August 17, 2012. Attachment 1, §812 (c)(1), Table 1, p. 1-4.

ADO. A design/policy manual for a program that specifies when wall and ceiling treatments are needed may be sufficient advance notice if the design manual is approved by the ADO. Program sponsors and consultants are advised to consult with their local ADO for further clarification regarding this issue.

While it is possible to achieve noise reduction by refurbishing existing windows and doors, most programs choose complete replacement of fenestration with acoustically rated products. (Note: Refer to Chapter 6 for guidance on where replacement of windows and doors in historic structures is counter-indicated.) This provides greater confidence in the results and longevity of the sound insulation.

The other potential sources of noise penetration require evaluation for their conditions and contribution to noise. The following sections will discuss them in further detail.

5.2.4 Treatment of the Residential Building Envelope

Once program standards and typologies are established from the windshield survey, treatment options can be designed. Architectural differences in housing styles across the country require considerable thought to make products visually appealing while meeting sound reduction goals. Local communities, especially historic districts desiring to maintain neighborhood character, will often want to review the style of products a program is planning to install.

A. Walls

While windows and doors are an obvious source for noise penetration into a building, the walls contribute to or detract from noise reduction as well. Per the acoustic principles discussed in Chapter 4, mass (density, weight) plays an important role in reducing sound transmission. Wood-framed homes are composed of the lightest mass construction materials of the standard American home. If the wood framing and siding does not conform to normal construction standards for materials and assembly, the walls potentially become a noise path. Concrete block or brick façades provide significant mass, thereby reducing the possible need to treat lightweight walls.

To achieve the NLR necessary to meet the acoustic goals, the first step is to determine the STC or NLR performance of the main structure of the building. The great majority of homes in the United States meet the minimum standard to achieve an STC of 37–40 in the wall construction. The diagram of a wall section in Figure 5.10 shows the minimum construction needed to proceed in sound insulation in the 65-dB to 70-dB DNL without consideration of treatment to the walls.

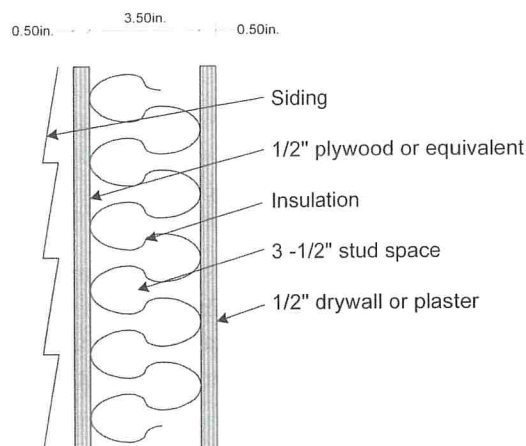


Figure 5.10. Minimum STC 37–40 wall.

Without insulation, the wall performs at 37 STC, and with insulation it can achieve up to 40 STC. If either the interior or exterior wall does not have the minimum ½-in. material with good mass properties, or the stud cavity is less than 3½ in., the wall may not perform to the standard necessary to create a consistent envelope when STC 38–40 fenestration products are installed. Closer inspection of homes during assessment will determine whether any exterior walls consist of a less-than-standard assembly of materials. Structures in 70-dB to 75-dB DNL may have higher STC needs that should be determined in conjunction with the acoustical consultant.

Wood-frame construction is susceptible to wind and termite damage. Investigate for any evidence of structural issues before adding additional load of drywall or other materials.

B. Ceilings

Evaluating noise impacts through roofs is an important component of providing sound insulation. Much like walls, the roof/ceiling needs to have a minimum STC performance to provide a consistent envelope before considering the impact from fenestration openings. The roof/ceiling assembly requires evaluation for its contribution to noise intrusion. A good discussion of ceiling considerations is in the 1992 guidelines.⁶ In the early practice of some programs, flat or monolithic roofs were built up with new roofing as an insulation treatment. Given wind and structural load issues, programs have developed interior treatments as an alternative. Programs need to establish the prevalence of ceiling impact and design effective treatments with the acoustical consultant.

The following list is a sampling of the ceiling/roof conditions that need to be assessed as potential noise paths:

- Lightweight construction materials, such as tin or Celotex ceilings or material with less mass than ½-in. drywall/plaster.
- Cathedral ceilings with no enclosed attic space above.
- Attic spaces that are uninsulated or that have large ventilation grilles.
- Flat, monolithic roof/ceiling systems without attic space or air space above. (Concrete flat roofs may be an exception.)

C. Attics

Attic spaces are considered unfinished space immediately below the roof structure. Various types of construction will contain openings into attics that create noise paths. These openings will need to be evaluated for their impact on the noise level in habitable space. A good discussion of attics and their acoustic impact is in Chapter 3 of the 1992 guidelines.⁷

Insulation. Where there is access into attic spaces and existing thickness is less than 6-in., provide insulation to the floor of attic spaces up to a maximum of 6 in. No insulation is required for floor spaces covered with plywood or flooring material providing adequate acoustical mass. No insulation will be provided where access into attic space does not exist and openings would have to be cut into the ceiling. Where the program is adding insulation, venting will need to be provided to meet code requirements. If existing venting exceeds code minimum sizes, vents may be acoustically baffled on a case-by-case basis.

Swinging Doors. Swinging doors to an attic or eave space should be replaced with a fully weather-stripped interior solid core door if the existing door does not meet acoustical guidelines. Install storm windows to existing windows to create a uniform, consistent appearance to the house.

⁶U.S. DOT, FAA, Report No. DOT/FAA/PP-92-5, *Guidelines for the Sound Insulation of Residences Exposed to Aircraft Operations*, October 1992.

⁷U.S. DOT, FAA, Report No. DOT/FAA/PP-92-5, *Guidelines for the Sound Insulation of Residences Exposed to Aircraft Operations*, October 1992.

Attic Hatch. If the existing hatch is tight fitting and consists of minimum $\frac{3}{4}$ -in. plywood or equal material, provide weather stripping around the perimeter only. All other hatches are to be replaced with a fully weather-stripped hatch consisting of $\frac{3}{4}$ -in. plywood, $\frac{3}{4}$ -in. sound deadening board, and $\frac{1}{2}$ -in. plywood. If mechanical equipment is located in the attic space, the access opening may need to be enlarged to meet code requirements.

Pull-Down Stairs. All existing pull-down stairs are to have a sound-insulated enclosure. If the pull-down stair is in disrepair or will not allow the installation of the sound-insulated enclosure, replace the pull-down stair and install the sound-insulated cover.

D. Miscellaneous Openings

Any direct opening that connects the exterior to the interior needs to be reviewed as a noise path. This can include mail slots through the wall or door, through-wall fan vents that are not ducted, milk delivery slots in older homes, and unit ventilators. All of these items will need to be removed and the opening sealed with wall materials or new doors. Fireplaces require special consideration. While each fireplace system, especially manufactured units, will need to be evaluated, common treatments include glass doors on the firebox and a chimney-top damper. Installing glass doors on manufactured units may be prohibited by the manufacturer, particularly as it pertains to heat buildup in the firebox.

5.2.5 Treatment of Residential Fenestration

As discussed throughout these guidelines, building codes are adopting increasingly stringent energy efficiency requirements. These requirements extend to replacement of residential fenestration. When determining treatments and selecting products, be aware of solar heat gain coefficients and U-values. Specific to the climate region where the program is located, these requirements affect the type of glass that may need to be put in the windows and the overall energy performance of the assemblies.

A. Windows

Choosing a window for a residential sound insulation program involves investigating many areas of performance. Some questions regarding performance that most homeowners will be concerned with are: Will it be a quality product that will hold up over time? How is it going to look in my home? Can I clean it? What do I have to do to maintain it? Can I still fit my plants on the window sill? Will it really reduce noise?

Other criteria that will directly affect homeowners are installation and aesthetics. How easy is the window product to install? How much of the wall needs to be disturbed to get a good installation? The answers to these questions often depend on the construction of the house. Not all houses were built with the thought of easy window replacement, but careful planning can minimize the time and cost of installing the right product. Programs should also take into consideration a homeowner's maintenance costs, the most common of which comes from replacing acoustical glazing should it be broken. If a program uses a window with expensive, laminated, argon-filled glass to meet the performance criteria, it is unlikely that the homeowner will replace the acoustical glazing with identical material.

The issue of aesthetics is crucial to many homeowners since it affects the value of their property. A colonial house with traditional windows may be easier to retrofit with replacement windows than a modern beach house with huge expanses of glass.

Introduced in the 1990s, acoustic vinyl and vinyl composite windows, specifically designed for residential sound insulating programs, have become the preferred window type for many programs. Some programs use dual metal windows; however, the increasing energy performance

required in many code jurisdictions will require careful review to confirm if they will meet code requirements for U-values, condensation resistance, and thermal performance. A detailed examination of acoustical windows is in Chapter 9.

The use of secondary glazing products, or storm windows, can help create the conditions essential for aircraft noise reduction. Wood replacement windows with the addition of secondary storm windows are offered in a third of all programs and have been approved for application in historic properties.

Residential windows have a standard variety of opening configurations, including double hung, sliding, projecting, and fixed. There are some variations on this that are available in high-quality custom windows, such as pivot-hinged windows, but these options are not available in the U.S. acoustical market. There are also some regionally specific window types, such as jalousie windows in coastal regions, that cannot be replicated in acoustic windows. In addition to operational configurations, nonrectilinear shapes require review for product availability. Custom or curvilinear shapes are difficult to manufacture in vinyl and expensive in other materials.

In some programs, home security is an issue that can affect the scope of work for installation of new products. When homeowners have protective metal grilles on windows, programs have to evaluate the life-safety code requirements for ease of egress without special tools or knowledge of how to operate the window. In other words, during an emergency, a window must be easy for occupants to exit through or for firefighters to enter. Programs take various approaches to this issue. For the window hardware itself, most programs provide standard industry hardware. For protective grilles, some programs remove them without replacing, leaving the resolution to the homeowner, while other programs adapt grilles with emergency hardware or install new grilles with current, code-compliant hardware. With the general increase in depth of the acoustic window product, reusing the existing grilles can be problematic without adjustment.

There are many details involved in treating windows, such as color, sizing, decorative elements like mullions and grids, art glass, garden windows, sidelights to doors, installation details, and the likelihood that window treatments will require adjustments to be reinstalled. Homeowners will have concerns about these specifics that the program needs to address and record in its PPM.

B. Doors

Each successful sound insulation program needs to consider what types of doors are architecturally appropriate to the neighborhoods where they will be applied and look carefully at what homeowners have selected. The technical challenges of sound level reduction can then be resolved with door types and styles that homeowners will see as appropriate.

There are three basic primary entrance door types used in sound insulation projects: steel/metal, flush wood, and wood panel (stile and rail). Fiberglass doors, while increasingly popular in home renovations, do not currently provide the necessary acoustical performance criteria for SIPs. Many homes have French or patio doors of various types, such as sliding, single hinged, and hinged pairs.

Most acoustically rated doors use mass as the primary method of reducing sound transmission. Where mass alone cannot achieve the goal or where those options are not agreeable to homeowners, a successful solution is installing a primary and a secondary door. Secondary doors create an air space with the primary door and a consequent decoupling between the two doors. This significantly increases the sound transmission loss of the door opening. A third option is to eliminate flanking sound paths with good gasketing. All primary and secondary doors must have excellent gasketing and weather stripping to be effective.

While stand-alone acoustical doors without glazing are offered in many programs, many programs also provide custom-quality doors with insulated glass installed with secondary storm doors. Only a handful of manufacturers make STC-rated flush doors that have a high enough

STC rating to be used without a secondary door. Homeowners are more receptive to this stand-alone product in regions where storm doors are not commonly used.

Flush or flat doors do not complement the architectural style of houses in many areas of the country. Panel doors are more compatible to the architecture found in older communities and cooler climates. To remedy this problem, applied moldings can be added to flush doors to simulate the look of panel doors.

Steel doors are available with a wide range of STC ratings, including the very high ratings needed for recording studios and other special uses. Steel doors are available with STC performance in the ranges needed for SIPs, but they are often not very residential in appearance. Some manufacturers make an embossed or pressed-in panel to simulate the look of a panel door or apply moldings to the surface of a flush door. Acoustically rated steel doors for exterior use are a solid choice in situations where a secondary door cannot be installed and where a fire rating is needed.

Wood Panel Doors (Stile and Rail). In the regions in which these are used, they are customarily installed with secondary doors. Some wood panel doors have not been laboratory-tested for STC rating, and generally none have the combination of primary and storm doors mounted together. Since the primary and storm doors are usually made by different manufacturers, there is little laboratory testing of the two products as a single assembly. Nevertheless, sound insulation programs have found through extensive field testing that the necessary noise level reduction for door openings can be achieved using high-quality residential products with an intervening air space. This field testing has shown that panel doors can be used for SIPs when they are constructed with wood of a density and thickness that is greater than standard raised panels installed between stiles and rails. Figure 5.11 shows two door sections. The door on the left has been accepted for use in SIPs. Note that the raised panel is thicker in both the main section and in the edge that joins with the stiles and rails. Figure 5.12 shows the installation with full-lite secondary products over the door and sidelights. The door must be fully gasketed, and glazing should be insulated glass. This type of construction is available from a number of fabricators. This solution nicely meets the needs of aesthetics, acoustics, and durability.

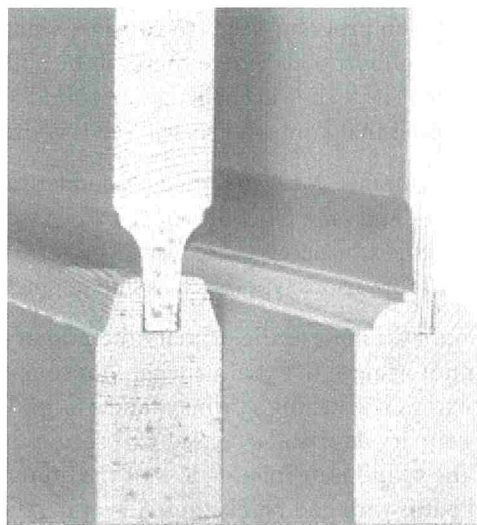


Figure 5.11. *Wood panel, sound-insulating door compared to builder's-grade panel door.*

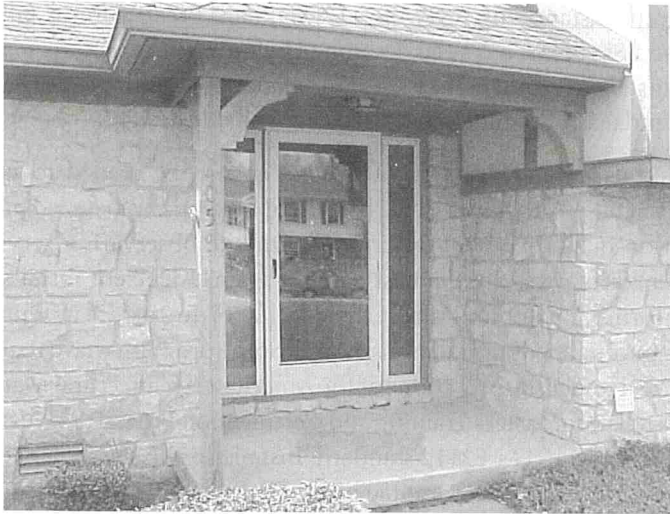


Figure 5.12. *Secondary products over door and sidelights.*

Flush Wood Doors. Flush wood doors for exterior use often require that the doors be protected from the weather with overhangs or secondary doors. If these conditions cannot be met, a warranty may not be available from the manufacturer. Some programs instead purchase an extended warranty from the installing contractor. Occasionally homeowners who select wood doors want them stained and varnished. Unfortunately, even the best exterior varnishes have a short life and must be reapplied at least every other year. Several programs have eliminated stained finishes due to their climate and maintenance concerns.

Patio Door. Patio door models suitable for sound insulation programs are available in wood, aluminum, swinging, and sliding. The choice is largely driven by the prevalent architectural styles and homeowner preference. Only a few aluminum doors are manufactured with the STC ratings required to meet the needs of a stand-alone, single unit in a sound insulation program. Where an alternative appearance is desired, a secondary door is required. There is a limited selection of sliding aluminum secondary doors available that will provide the necessary noise level reduction through decoupling. These can be used with in-swinging hinged and sliding patio doors of various types.

C. Fenestration Installation Considerations and Methods

Sound insulation programs are by nature retrofit or replacement programs. Since all of the products will be replacing existing windows, it is important to consider the constructability characteristics of these replacements. How well does the window work as a replacement? Is it available in custom sizes? How thick is the frame, and will it fit in the walls? A 6-in.-deep window will not fit in a standard wood-frame wall without special modifications to the opening. Does the window have installation extrusions like nailing flanges or snap-on trim? If a home is occupied, how quickly can the windows be installed to minimize homeowner inconvenience?

Proper Installations. Proper installations begin with good design of flashing details incorporated into the project's construction documents. Information on proper flashing is found in a number of sources, such as the Sheet Metal and Air Conditioning Contractors' National Association (SMACNA) Residential Sheet Metal Design Guide, manufacturers' published data,

and architectural graphic standards. ASTM E2112, Standard Practice for Installation of Exterior Windows, Doors, and Skylights, has been developed by industry consensus to address the quality of fenestration installation and includes recommendations about proper flashing. Architects should use these standards and guidelines to produce suitable designs.

Of course, the best design poorly executed will not ensure the needed acoustic performance or homeowner satisfaction. Programs reduce the risk of improperly installed products by implementing construction quality control procedures. On-site observation services provided by qualified project representatives are the best defense against deficient installations. Observers can detect nonconforming work and direct the contractor to correct it. Qualified contractor personnel improve the quality of installations as well. Some programs have required contractors to use installers trained under the provisions of the American Architectural Manufacturers Association (AAMA) InstallationMasters Training and Certification Program.⁸ This program is based on the requirements of the ASTM E2112 standard. InstallationMasters is a nationwide training and certifications program that was prompted by the Building Environment and Thermal Envelope Council (BETEC) through the U.S. DOE and developed by the AAMA. Designed for new construction and replacement installers of windows and exterior glass doors in residential and light commercial markets, the InstallationMasters program is an important tool offered across the country.

Detailing the Fenestration Installation. This falls into two broad categories, *retrofit* (*pocket* for windows, *leaf* for doors) installation and *rough opening* or *unit* installation. Retrofit installations are used when the replacement acoustic product will fit easily into the existing opening with little modification to the window frame or wall. This is common in older, Eastern and Midwestern houses where window sashes were designed to be replaced without removing the entire frame. Retrofit installation of windows saves time, is less disruptive to homeowners, and allows less opportunity for construction issues. Presuming that the existing frame is in good condition, the installation needs to include insulation and sealants to prevent air and noise infiltration. Where window weight pockets exist, they need to have weights removed from the wall and have the remaining void insulated to increase acoustic performance. Figure 5.13 shows a typical jamb section at a pocket install for a vinyl composite window.

Rough opening or unit installations are used when the fenestration will not fit easily into the existing window frames or wall depth or when the conditions of the opening are deteriorated or not square and will not allow for proper insulation and sealant installation. Construction methods vary regionally, and window installations typify this difference. Recent construction practices, such as installing windows with nailing fins or using drywall surrounds to embed the window, make window replacement more difficult, often necessitating taking out the window trim/surrounds and frame back to the wall studs. This is considered the rough opening. Figures 5.13 and 5.14 are schematics for wood-framed walls; there are many types of walls. The important differences in adapting regional window installation details to sound insulation are:

- Overlap of materials to mitigate sound penetration,
- Proper insulation and caulking installation, and
- Consideration of wall thickness and trim detailing due to thicker and heavier products.

Replacement windows should be sized to match existing openings. All windows should be custom manufactured to meet the specified installation detail rather than being an off-the-shelf, standard size. The enlarging or downsizing of openings is not recommended except for specific

⁸ See InstallationMasters USA website, <http://www.installationmastersusa.com>.

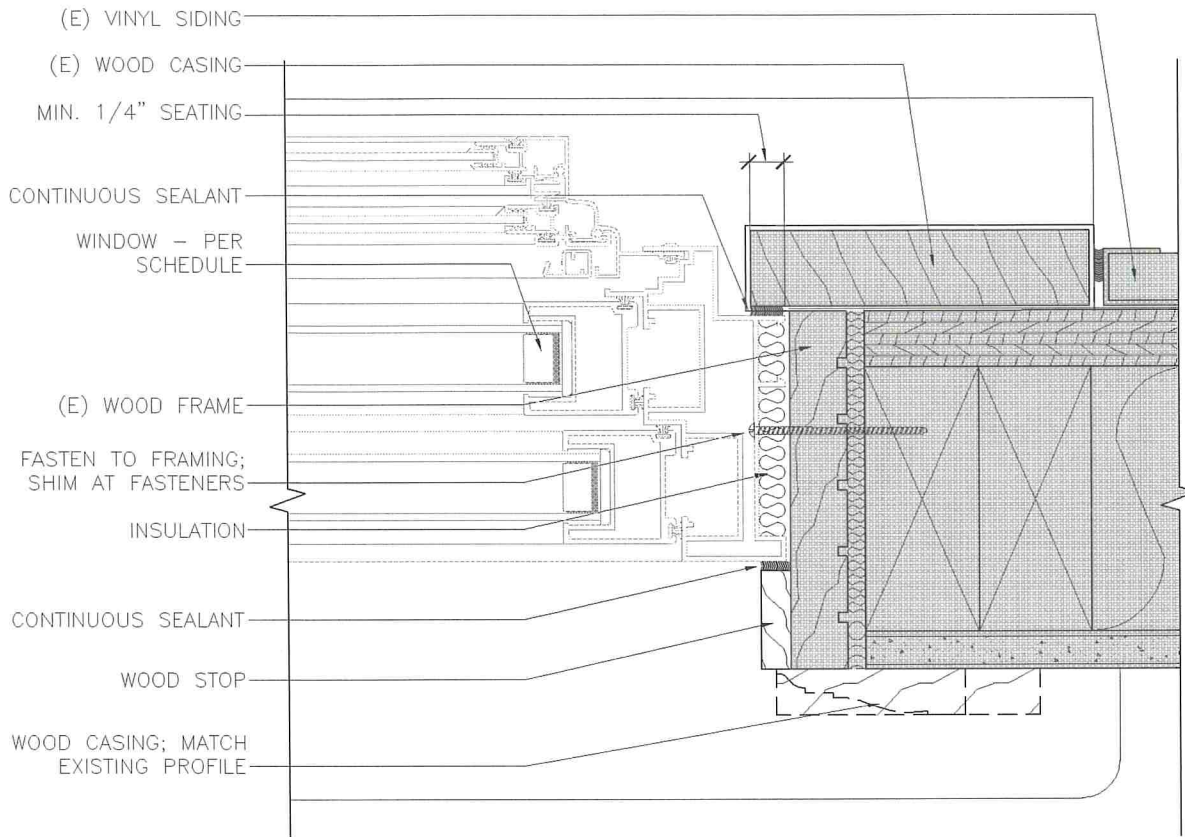


Figure 5.13. Retrofit installation jamb detail of vinyl composite window.

construction and life-safety egress requirements, such as when the window will be too small to allow for fire egress or the window exceeds the minimum or maximum dimensions of product availability.

For doors, the rough opening/unit or full-frame replacement has become the preferred method in most cases due to the reliability of the install compared to trying to adjust a new door to a frame that may be out of square or skewed.

Further information about installation is available in Sections 9.4 and 11.3.2.

D. Hurricane Impact

Hurricane impact code requirements are becoming more prevalent along the East and Gulf Coasts; however, they vary greatly depending on the wind speed and impact resistance requirements for the region. The first step in establishing the program's design requirements is to establish the maximum wind load for the project area. This is determined by referencing the state's approved building code map that describes expected wind loads for any given area of the state. Once the wind load is defined, the design pressure needed⁹ to withstand the wind load can be determined. Design pressure is one of the components of the AAMA performance standard used in the construction product industry to define classes of products. Determining the class of products sets the minimum quality standard for the program.

⁹See ASCE 7-02, Minimum Design Loads for Buildings and Other Structures.

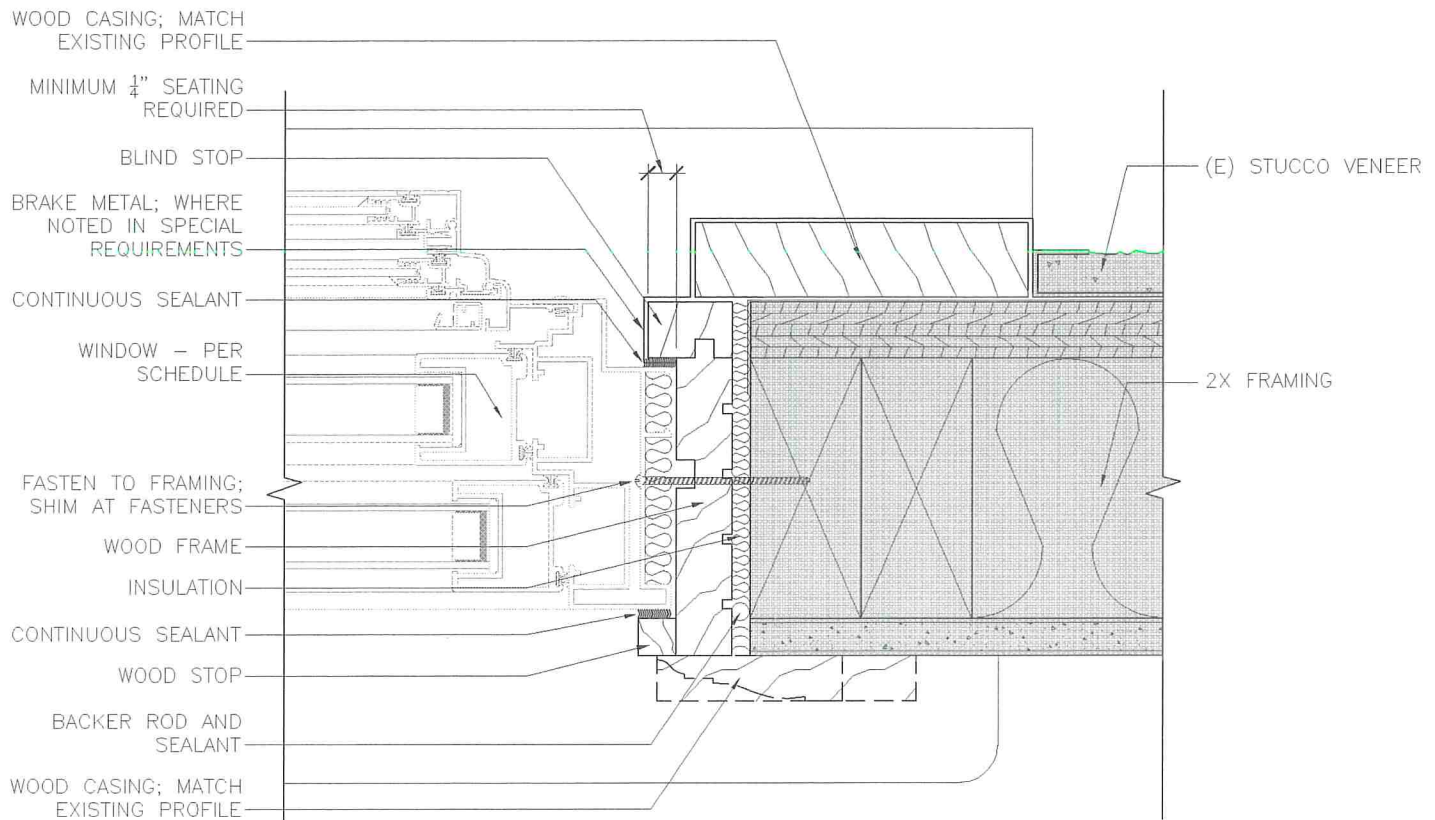


Figure 5.14. *Rough opening/unit installation jamb detail of vinyl composite window.*

It is important to note that design pressure requirements are separate from impact resistance requirements (another important performance requirement) and that the strength of window and door product frames and anchoring must respond to the designated wind load conditions.

Areas subject to hurricane impact are also prone to flooding, which can trigger an additional project work requirement that all mechanical equipment, including condensers and electric feeds, be raised above stipulated worst-case flood conditions.

There are two primary means of protecting the openings of homes in hurricane zones: impact-resistant products and physical barriers, such as shutters or removable impact panels bolted over windows and doors. Impact resistance requirements are very specific and extensive because doors and windows need to withstand the impact of small and large projectiles fired at specific velocities. While many manufacturers are developing window and door products to meet impact resistance standards, the focus has been on commercial rather than residential products. Impact resistance was added to the code as a way of ensuring that the exterior envelope of structures remained intact without the installation of large, heavy protection. The products, including glass, are essentially designed to bend but not shatter, thereby minimizing interior wind and water damage to the structure. Nevertheless, it is not unusual for windows and doors to be damaged.

Given the expense of replacement and the limited availability of acoustically tested products, impact-resistant windows and doors are relatively new to sound insulation programs. In some hurricane zones, the preferred protection for impact resistance is shutters or metal panels placed over windows and doors. If one adopts this design approach to deal with impact resistance, an important requirement is to maintain the required deflection distance between the shutter and

the acoustical door or window product, which are constructed with deeper frames than most non-acoustical residential products. Many frames are between 4.5 in. and 5 in., which allows room for deflection space when installed in a typical concrete masonry unit wall. In a typical wood-frame-constructed wall, however, accommodation must be made. It should be noted that in high-velocity hurricane zones, such as South Florida, air and water infiltration requirements are higher than the national requirements. This may limit the number of acoustic products available.

Balancing wind and acoustic performance requirements can be achieved by combining acoustically rated products with hurricane-resistant products. This is a good way to provide homeowner-friendly treatment options in hurricane-prone regions. For example, an out-swinging full-lite impact-resistant door can be paired with an acoustically rated in-swinging prime wood or metal door and meet or exceed noise reduction requirements. Cases where there are products that meet both impact and sound insulation needs are relatively few, thereby requiring the architect to be creative when writing specifications and selecting products that meet all the performance requirements.

5.2.6 Encountering Hazardous Materials

The presence of hazardous materials such as lead and asbestos may affect eligibility for inclusion in SIPs, as well as treatment approaches for certain building components. Under current federal and state regulations, the handling and removal of hazardous materials from residential structures in connection with building rehabilitation- and renovation-type projects is clearly defined. The handling of hazardous materials in the program is limited to areas where the acoustical and associated improvements are installed. Two primary hazardous materials, asbestos and lead paint, are often encountered in homes. In addition to federal requirements, each state and municipality will have abatement procedures for public work. Working with a local hazardous materials consultant to format policies and procedures is an important part of program formation.

Asbestos. Asbestos-containing materials encountered in the sound insulation process may be removed, altered, or disposed of under the construction contract. These may be found as part of the existing HVAC systems or in transite-type asbestos siding materials, which may be affected by window and door replacement. Work performed affecting these materials must be carried out in conformance with all applicable federal, state, and local regulations.

Lead Paint. Lead paint can be found in wood surrounding windows and doors as well as other potential areas affected by SIPs. If lead paint is present, it does not exclude the residence from the sound insulation program. If, however, a homeowner has been issued an order to de-lead by a responsible authority, the residence may need to be placed on hold until all de-leading activity has been completed and certified by the responsible oversight agency.

Mold and Radon. Mold and radon, although not addressed as hazardous materials as such, can pose environmental health problems. Specific to the climate of each SIP, programs will need to develop policies on appropriate actions to take if these items are discovered in the structure. Chapter 7 addresses the indoor air quality and ventilation requirements of homes in SIPs.

Appropriate federal, state, and local regulations must be followed where the installation of acoustical treatments or associated treatments may disturb known or suspected lead-paint-containing materials. The U.S. EPA's web page for the Lead Renovation, Repair, and Painting Program states that:

Common renovation activities like sanding, cutting, and demolition can create hazardous lead dust and chips by disturbing lead-based paint, which can be harmful to adults and children. To protect against

this risk, EPA requires contractors performing renovation, repair, and painting projects that disturb lead-based paint in homes, child care facilities, and schools built before 1978 must be certified and must follow specific work practices to prevent lead contamination.¹⁰

It is important that contractors working on SIPs are compliant with the EPA's Lead Renovation, Repair, and Painting Program.

5.2.7 Building Codes for Residential Buildings

The first step in evaluating building codes for sound insulation is to determine which versions of codes are in effect for each jurisdiction affected by the program. Each state, county, and municipality may have different legislation establishing jurisdictional power to set codes. Determine if there are local code requirements or zoning provisions that supersede the model building codes adopted by the state. Local provisions are particularly important when it comes to interpreting codes for renovation and can place additional performance requirements on residential SIPs. Code interpretation is largely dependent on whether the local authority having jurisdiction rules that the sound insulation treatments constitute a renovation of a major system rather than being simply a repair or replacement of an existing building component. In some jurisdictions, installation of acoustical doors and windows is considered to be a major system renovation that triggers other work requirements. Installing HVAC systems requires a building permit in most jurisdictions and is considered a major system renovation in a residence.

PGL 12-09 states, "If it is determined in the course of designing a sound insulation project that a building needs improvements in order to conform to local building codes, only the costs of sound insulation are allowable."¹¹ The intent of this statement is to limit the responsibility of SIPs to correct a structure's outstanding maintenance issues using AIP funds. In order to conform to local building codes, installation of code-conforming acoustical treatments is required. When a building was properly built under the prevailing code of its time, updating aspects of the structure to accommodate the installation of sound insulation treatments may be acceptable. For example, if a bedroom window opening has to be enlarged to meet egress requirements per local codes, the cost of creating a larger opening is an allowable program expense. Or, if the code requires impact-resistant windows or storm shutters that must remain a defined distance away from thicker windows, thus requiring modification of the window opening, this is an allowable cost. However, there are many situations where it is difficult to separate the acoustical treatment from the code-conforming installation of the treatment. **Program sponsors and consultants are advised to consult with their local ADO for further clarification regarding this issue.**

A. Defining Habitable Space

Previous chapters in these updated guidelines have discussed the issue of treatment eligibility based on acoustical factors. Not every space that qualifies for treatment based on acoustical factors necessarily qualifies for treatment, depending on the program definition of habitable living space. Not every SIP has had the same criteria for determining what spaces within a residence are habitable. This is due to three factors: (1) varying interpretations of building codes on what constitutes "habitable space" or "living space," (2) a lack of specificity in previous versions of the guidelines, and (3) community expectations for treatment consistency in each home.

¹⁰ Renovation, Repair, and Painting Program – Related Information, United States Environmental Protection Agency, accessed January 2012, <http://www.epa.gov/lead/pubs/rrp.htm>.

¹¹ See note 4. Attachment 1, §812 (c)(3), Table 3, p. 1-8, 1-9.

The 1992 and 2005 versions of the guidelines attempted to address this issue by providing guidance for the treatment of habitable rooms and living spaces. Unfortunately, code definitions of living space and habitable space are not the same. Specifically, the definition of a habitable space excludes “bathrooms, toilet rooms, closets, halls, storage or utility spaces, and similar areas,” whereas the definition of living space includes spaces for “bathing, washing, and sanitation purposes.” The full definitions of these terms as provided in the 2009 and 2012 versions of the IRC are provided in the following.

“Habitable Space – A space in a building for living, sleeping, eating, or cooking. Bathrooms, toilet rooms, closets, halls, storage or utility spaces and similar areas are not considered habitable spaces.”¹²

The concept of habitability establishes standards for building planning, general health, life safety, egress, and minimum room dimensions. This forms the key reference for determination of which spaces within a home are eligible for treatment. While this habitability definition excludes bathrooms, toilet rooms, closets, halls, or storage or utility spaces, the code further defines “living space” as:

“Space within a dwelling unit utilized for living, sleeping, eating, cooking, bathing, washing, and sanitation purposes.”¹³

Living space as defined in the International Mechanical Code includes any space that receives HVAC, including hallways, bathrooms, laundry rooms, and foyers. Living space identifies the total occupiable portion of a building that requires appropriate engineered systems for comfort and livability.

Note: Therefore, for the purposes of SIPs, the FAA limits *architectural* treatments to code-defined habitable rooms, while *mechanical* treatments must encompass the code-defined living space to meet code requirements.

B. Determining Architectural Treatment Eligibility

Some programs have used the definition of “habitable space” to create narrow parameters for treating only those rooms used for living, sleeping, eating, or cooking. Other programs have used the definition of “living space” to treat all interior spaces.

FAA directs that:

Eligible projects may include noise insulation of only the habitable areas of residences such as living, sleeping, eating, or cooking areas (single family and multifamily). Bathrooms, closets, halls, vestibules, foyers, stairways, unfinished basements storage or utility spaces are not considered to be habitable.¹⁴

Supplementary treatments for architectural consistency to areas that the FAA determines ineligible for treatment cannot be reimbursed under AIP funding. Programs have found that homeowners have challenged policies that create inconsistency in their home’s exterior appearance or in sound insulation performance by not having hallways, laundry rooms, or bathroom fenestration treated. Consult with the local ADO regarding rules for applying local funding to provide consistent treatments.

C. Evaluating Habitability

The great majority of homes built to industry standard practices will meet code requirements for habitability. Dwellings built prior to codes or ones that have been altered, built onto, or

¹² International Code Council, Inc., International Mechanical Code. 2009, 2012.

¹³ International Code Council, Inc., International Mechanical Code. 2009, 2012.

¹⁴ See note 4. Attachment 1, §812 (c)(3), Table 3, p. 1-9.

Table 5.2. Potential habitability issues based on 2009 IRC and best practices.

Code Issue	Minimum Code Standards
Egress Requirements	
For rooms used for sleeping purposes	Must have one means of egress that meets code minimum dimensions for clear opening, max sill height with no obstructions that impair egress.
Ceiling Height, Material, and Structure	
Height	Minimum 7'0".
Impediments	Not less than 6'4".
Adequacy of structure	Must support barrier materials.
Insulation and venting	Sufficient to meet code minimums.
Room Dimensions	
For dwelling unit	Must have one room not less than 120 ft ² .
For defined "habitable" rooms in units	Not less than 70 ft ² and not less than 7'0" in any dimension.
Indoor Air/Light Quality	
	Minimum window area of 8% of floor area per room for light with 4% operable or vented by mechanical means
Heat	
	Determine winter design temperature. If qualified, must achieve minimum 68° F (cannot be space heaters).
Mechanical Ventilation	
Combustion air for fuel burning heating	Must meet code requirements.
Carbon monoxide and smoke detectors	Must meet code requirements.
Electrical	
Defective wiring	Must meet code requirements.
Noncompliant but nondefective	Can be grandfathered.
Foundation	
Barrier skirting	Equivalent to min ½-in. plywood with venting.
Structurally sufficient	Must be adequate to meet both existing and acoustical treatment loads.
Walls	
Insulation	As required to meet code.
Interior wall material	Equivalent to min ½-in. gypsum board.
Exterior wall material	Equivalent to standard sheathing and siding.
Floor	
Continuous barrier material	Equivalent to min 5/8-in. plywood; no gaps.
Insulation	As required to meet code.
Windows	
Prime windows	Maximum air infiltration – 0.50 cfm/lin ft crack perimeter.
Doors	
Prime door	Maximum air infiltration – 1.25 cfm/ft ² .
Adequate landing	Min. 36 in. both sides of door.
Other	
Laundry and toilet rooms	Natural or mechanical venting as required by code.
Mechanical room and garage	Fire separations and venting as required by code.

subdivided will often require more careful assessment of physical conditions, which is the basis of code determinations of habitability. Table 5.2 is based on the 2009 IRC and provides a list of physical conditions relevant to SIPs that should be evaluated in each home to determine whether spaces that are acoustically eligible for treatment also meet code habitability requirements.

Remediating conditions in spaces that make them nonhabitable, such as inadequate room dimensions, improper heating or sanitation, or insufficient light and air, can require significant effort. Any deficiencies in these basic building standards that are not corrected may cause difficulties with building inspections during permitting and construction and, as such, should be addressed before treatment recommendations are finalized and treatments are bid. Many programs either disqualify homes or specific rooms within homes with such issues or allow the homeowner the opportunity to correct the issues and return to the program at a later date.

D. Code Requirements That Affect Treatment Recommendations

The consultant team will need to conduct a code review as an essential part of program start-up. This review will need to include consultation with the local building authority on code interpretation as it applies to the intended program treatments. During property assessments, the design team will look for and take note of existing conditions that do not conform to code and may potentially affect treatment recommendations. When surveying existing conditions, there is no implied or expressed intent to conduct a detailed code review and analysis or to identify all nonconforming conditions that may be present in the residence. The scope of the survey is limited to identifying any conditions that may affect treatment recommendations at a given location or for the residence as a whole. The intent of the program is not to undertake extensive remedial measures to correct outstanding deficiencies to allow implementation of the acoustical treatments. The program focuses only on the mechanical, electrical, structural, or code issues that will affect proper installation of the sound insulation products as recommended. The responsibility for resolution of these deficiencies may belong to the property owner, depending on the negotiated environmental impact study or local program funding.

Code-required items to be assessed include:

1. Does the door opening conform to required dimensions of height and width? Are there as many doors as the code requires? Some jurisdictions require two egress doors from a residence.
2. Is the height of threshold at egress doors less than allowed by code so that they are not a trip hazard? This can be a particular issue at basement openings through foundation slabs and walls and sometimes at doors out to balconies.
3. Does the door open to a code-conforming landing? Is that landing in sound condition? (See Figure 5.15.)



Figure 5.15. *Door landing in poor condition.*

4. If new HVAC systems are being installed, does the electric panel meet the requirements for the work to proceed? While the wiring for the whole house is not checked, are there nonconforming conditions for elements of the system that the program will be altering?
5. Life safety items that local code officials often require as part of SIPs are smoke detectors and egress windows.
 - a. If a home does not have smoke detectors, it is often required that SIPs install them. The consultant team should confirm with local building officials if they need to be hard wired or if battery-operated ones are acceptable.
 - b. The requirements for bedroom window sizes for access by firefighters have increased decidedly since most of the homes in programs were built. Many homes in the 1960s were built with then-popular long, high ribbon windows. These windows are now too high from the floor (>44 in.) and too small (<5.7 ft²) to meet current egress standards. Many jurisdictions require SIPs to enlarge the openings and lower sills to meet emergency requirements, whether the walls are concrete block, wood frame, or brick.

5.2.8 Developing Program Standards

As a publicly funded activity, sound insulation programs treat single residences within the context of neighborhoods. This means that while each home and homeowner is unique, they must be treated within the framework of a program with well-defined guidelines and standards that are equitably applied. The most successful programs are those that provide consistent treatments while including a rule set for addressing unique issues. This can be an important asset when homeowners believe neighbors have received benefits they have not.

Chapter 3 deals with various methods of community outreach, while the specific program standards that outreach will communicate are discussed throughout these guidelines. Specific mention needs to be made here about a particular challenge inherent in communicating program standards, which is communicating a consistent message throughout the process. Programs vary in how they accomplish this, but a couple of methods are:

1. Programs can have a single point of contact (a homeowner liaison, which can be either a sponsor employee or a consultant) for speaking with homeowners. This reduces the potential for inconsistent messages. This person must be able to address all aspects of the program.
2. Programs should prepare written scripts for program personnel to deliver at the appropriate stages in the process. Practice these talks and review potential ramifications of not staying on message. Homeowners are neighbors and will compare what they are told by program representatives.

As the program develops its standards, being mindful of how they will be communicated and perceived will facilitate community participation.

A. Establishing Program Protocols with the ADO

PGL 12-09 speaks to providing conformity of treatment at the neighborhood level:

To ensure community support, it may be reasonable to include provisions for neighborhood equity in a noise insulation project. In these cases, the sponsor develops two sets of noise insulation packages. The standard noise insulation package will be prepared for residences that meet the interior noise criteria. A second package will be prepared consisting of other improvements such as caulking, weather stripping, installation of storm doors, or ventilation packages for residences that are not experiencing interior noise 45 dB or greater.¹⁵

¹⁵ See note 4. Attachment 1, §812 (d)(1), Table 4, p. 1-11.

However, use of this secondary protocol is significantly restricted:

In order for grant funding to be available for the secondary package, participation must be limited by FAA policy to less than 10 percent of the residences in the neighborhood (as logically bounded by either streets or other geographic delineation), but by FAA policy in no case more than 20 residences total in a phase of the noise insulation program.

Where there are more than 10 percent or 20 residences proposed for neighborhood equity packages, the costs of this work must be funded with other, non-federal, sources of funds.

If a sponsor proposes the use of secondary packages for neighborhood equity, the sponsor must provide a list to the ADO that outlines the number of residences that are proposed for noise insulation, breaking down the residences that meet criteria and those that do not. The sponsor's report must also provide detailed information about the proposed neighborhood equity package including costs of the secondary package compared to the cost of a standard noise insulation package.

The ADO must review and approve/disapprove the sponsor's proposed neighborhood equity package to ensure that the use of the minimal neighborhood equity packages on non-eligible residences is required to allow successful completion of the overall noise insulation program in the neighborhood, thus allowing these residences to be noise insulated within the guidelines of AIP eligibility. The ADO must document the approval of the noise insulation package in the project files.

In extremely rare cases, the ADO may determine that the program will benefit by providing noise equity packages to more than the 10 percent/no more than 20 residence limit. In this instance, the ADO must receive APP-1 approval to exceed this limit.¹⁶

B. Assessing Level of Flexibility in Design

An important start-up task is to determine the values and acoustical needs that will guide the program and formulate them into a policy and procedure manual. These values are informed by investigating policy questions such as:

- Will the levels of treatment vary according to the noise contour? Will all homes be offered the same palette of treatments?
- Is there a budget or spending cap that the program will set on a per-house basis or as a percentage of the home's assessed value?
- Will this budget achieve the quality the program needs to satisfy affected homeowners?
- How much flexibility and choice will the program offer, for example, in options such as color, material, or style of windows and doors?

Once the guiding values are established, the program formation process should lead toward the selection of consistent, standardized program protocols. Identify the level of design flexibility that is to be allowed in the program. By understanding the level of unique design issues identified in the contour area through the windshield survey, informed decisions can be made. Small programs may have room for more individualized attention to variations and customization of treatments, whereas large programs may have to limit choices in order to maintain the pace of the program and secure quality control. Chapters 2 and 10 discuss program management structures. Criteria for choosing a management structure include considering how much flexibility the program needs to serve its community and deciding at what pace homes need to be treated.

C. Determining Regional Product Expectations

Each region of the country has unique features to its residential construction that require consideration when designing acoustical treatments. Climatic conditions necessitate thermal, solar heat gain, and wind load performance on fenestration products that are locally defined.

¹⁶ See note 4. Attachment 1, §812 (d)(1), Table 4, p. 1-12.

Styles of homes may determine materials that are appropriate and incorporate window patterns with customized shapes. If the program is in a high wind region, the window will be subjected to damaging pressure, thereby requiring a stronger frame and hardware or thicker glass. By understanding both the requirements for noise reduction and the expectations of homeowners and local codes, programs can offer sound insulation treatments that are effective and regionally appropriate.

Another consideration when choosing products is whether more than one manufacturer makes the product that the program requires. If only one source is available, special procedures are in place with the FAA and other public funding agencies to approve a sole source provision, but these are time consuming and require extensive documentation and should be avoided if possible. While meeting a specific need, choosing a sole source product limits competitive bidding. Availability is also a factor in choosing products. Consider the ability of a manufacturer to meet the construction schedule when making promises to the community. If the program chooses a product that has limited availability, the delivery of treatment to homeowners will require adjustment.

D. Program Specifications and Evaluating Products

Construction professionals, architects, engineers, and general contractors use written specifications to communicate the quality of products to be installed in a given project. The creation of standard program specifications establishes quality levels for programs, ensures consistency between bid packages and in neighborhoods, puts research in the design phase rather than during shop drawing and submittal reviews when time is constricted, and helps project costs for bidding. To provide clarity on the quality expected, specifiers use performance standards that are promulgated by testing agencies and professional associations. Designations such as HMMA (Hollow Metal Manufacturers Association), ASTM, and AAMA refer to organizations that establish product standards. These standards provide a common language for designers and contractors to use in choosing the right product for a project. Products are reviewed according to their ability to meet minimum requirements such as air infiltration, water infiltration, thermal performance, and strength under stress conditions. Additional performance characteristics are considered for products that are to reduce noise, such as STC or NR (noise reduction) ratings.

Establishing a performance standard should involve an understanding of what is available to meet the standard. There are manufacturers of architectural products that serve the sound insulation market. This is further discussed in Chapter 9, with some current product manufacturers listed in Appendix C.

While the national providers are an important element in providing quality sound insulation, working with local companies can be useful to a program. However, the local companies must meet standards for warranty, quality, consistency, and performance. If they are not familiar with the paperwork required for participating in a federal program, they may need to be guided through the process. One purpose of a pilot program may be to test local products or new theories on installation in an unusual construction type. Also, a new assembly of materials can be field tested to determine their effectiveness.

An important aspect of evaluating products for inclusion in AIP-funded projects is satisfying the federal Buy American requirements. A reference to the Buy American Act is in Chapter 11 under the section on program assurances.

ACRP Legal Research Digest 18: Buy American Requirements for Federally Funded Airports was published in March 2013. It is a useful reference for sponsors and consultants who have questions regarding Buy American requirements for AIP-funded programs such as SIPs.

5.2.9 ACRP Project 02-31, “Assessment of Sound Insulation Treatments”

At the time of the publication of these guidelines, the Airport Cooperative Research Program began ACRP Project 02-31, “Assessment of Sound Insulation Treatments,” to conduct research and provide evaluation of the performance of acoustical products and treatments in previous SIPs, including the proper maintenance required to ensure the longevity of the installed acoustical treatments. It is recommended that users of these guidelines review the results and recommendations of ACRP Project 02-31 for further information regarding sustainable and effective noise reduction products and treatment strategies.

5.2.10 Best Practice Recommendations: Residential Treatments

1. Conduct a thorough inventory of the housing stock to catalog eligible buildings in the contour if that was not already done as part of the Part 150 noise compatibility study.
2. Establish typologies to help generate program policies that can be applied across multiple residences without necessarily acoustically testing each home to determine treatment goals.
3. Understand that the codes for residential and institutional buildings differ greatly, especially if working on both types of properties.
4. Pay special attention to noise paths of home additions since these additions can be built of lighter-weight construction than the rest of the home.
5. Implement construction quality-control procedures to reduce the risk of improperly installed products. The best design poorly executed will not ensure needed performance or homeowner satisfaction. On-site observation services provided by qualified project representatives are the best defense against deficient installations.
6. Two primary hazardous materials, asbestos and lead paint, are often encountered in homes. Work with a local hazardous materials consultant to formulate policies and procedures as an important part of program formation.
7. Allow for the consistent treatment of all windows, doors, and ventilation systems that are part of the occupiable home and subject to noise disturbance.

5.3 Public Buildings

In addition to residential structures, noise generated by airport operations affects noise-sensitive structures like schools, libraries, places of worship, nursing homes, hospitals, community centers, and performance spaces. Unlike residential structures, where a typology of architectural features can be determined, public buildings will be unique in design and construction. Therefore, while the *AIP Handbook* is more specific on residential structures, it understands that the treatment protocols for public buildings will require custom sound insulating solutions.

The *AIP Handbook*, FAA 5100.38C, Chapter 8, Section 812.c, states:

For schools, the usual design objective for classroom environment is a time-average A-weighted sound level of 45 dBA resulting from aircraft operations during normal school hours. As with residential noise insulation, a school project should reduce existing noise levels by at least 5 dBA for the same time-average school hours' time frame.

General practice is that requirements for schools set the standard for treatment of other non-residential properties. Aircraft over-flights can cause disruptions to the ability to understand speech in such structures. Many noise mitigation programs adopt speech interference metrics as a guide to providing appropriate levels of sound insulation in classrooms, churches, and other noise-sensitive public spaces.

The use of the term “usual” in the FAA guidelines for schools allows room for the application of supplemental metrics as the study of the impact of noise on learning continues to evolve. The standard recommended by FICAN is to provide an interior learning environment with no greater than a 60-dBA noise level during the 95th percentile of the flights in order to eliminate speech interference.¹⁷ This is described as L_{\max} , or maximum level of noise.

5.3.1 Treatment Strategy

To achieve a balance of cost, constructability, and acoustic performance, coordination of structural, mechanical, and acoustic design is required. Using engineering calculation models to project the performance of modifications provides the basis for the recommended sound mitigation treatment options.

A. Building Envelope

As with residential projects, walls and ceilings are the first elements to be reviewed for noise paths. Public buildings have larger spaces than homes, and the potential percentage impact of a lightweight ceiling/roof is great. In general, the walls of public buildings are constructed of heavier mass than wood-frame construction and rarely require direct treatment. However, the opposite is true for the ceilings. As shown in the before-and-after photos of a treated community space (Figure 5.16), the lack of a ceiling covering the exposed roof deck was the major noise path into the space. Several skylights and direct venting HVAC systems further increased the noise penetration. The windows and doors were a minor noise path into the space. Treatment of ceilings involves lighting and mechanical penetrations as well as structural reinforcement for new loads.

B. Mechanical Systems

Working in public buildings requires a different level of communication and discussion than residential work. Most of the noise-sensitive institutions are public or not-for-profit organizations, and renovations to their buildings will occasion questions about the operational costs of any new systems in their buildings. Fortunately, the new systems are usually much more energy efficient than what will be replaced.

Providing ventilation for public buildings is much more complex than for residential buildings. Commercial building codes govern construction and renovation of schools, places of worship, and community buildings. This means fresh air requirements and thermal loads are more exacting based on the occupancy of the building.

Some buildings are part of a larger institutional system, and treatment decisions may need to be reviewed in the context of facility standards. For example, school systems may set standards for levels of quality or energy usage of equipment in their buildings. In one northern region elementary school, a unique program of ducted ventilation air with an innovative low-tech cooling option using ceiling fans was selected over an air conditioning option due to operating costs

¹⁷ Federal Interagency Committee on Noise, *Federal Agency Review of Selected Airport Noise Analysis Issues*, Technical Report, Volume 2, August 1992.



Figure 5.16. *Community building before and after treatment.*

and the desire to avoid setting an unattainable precedent for schools in their district outside of the noise contour.

C. Building Codes for Public Buildings

There are many components to a successful nonresidential sound insulation project, but it is important to determine early in the process which governmental entities have jurisdiction over the project and what their distinctive requirements and approval processes are. It is not unheard of for state, school district, and local jurisdictions to have unique regulations and submittal requirements. Project schedules must be adjusted to allow for review at each level. In school construction, be aware that some agencies may have extensive review time, depending on their current backlog or time of year.

The code analysis starts with the International Existing Building Code if the jurisdiction has adopted it. As with residential projects, it is imperative for the program to provide a code analysis of the projected scope of work to the building officials early in the design process. The discussion will need to identify what level of repair or alteration the building officials assign to the work. For mechanical system replacement, the International Mechanical and National Electrical Codes will govern the work.

As with residential projects, most of the public buildings that are eligible for sound insulation were built prior to current code standards, necessitating a thorough review of the existing conditions. If building elements that require accessibility for people with disabilities are to be replaced as part of sound mitigation, the proposed treatments will reflect those requirements.

5.3.2 Defining Eligibility Within a Building

Under FAA guidelines, all occupied school spaces are eligible for treatment except gyms, cafeterias, and hallways, unless these spaces are used for instructional activities and assemblies. Offices in schools are eligible for treatment under this FAA guideline. Offices are supportive to the main educational and community purpose of the building and do not comprise the majority of the building. Programs need to evaluate the percent of the floor area not used for congregating or instructional activities and establish a policy on recommendations for treatment of those areas.

When treatment recommendations do not include treating every exterior opening of a building, consideration should be given to façade consistency and reasonable design judgments for architectural continuity. Some programs have allowed schools to contribute to the construction costs of coordinating treatments for non-eligible spaces. Accounting for this cost sharing may require a memorandum of understanding with the regional FAA and full disclosure in the construction contract.

5.3.3 Schools

A. Impact to Learning Environment

Since FICAN's 1992 recommendation, the standard for classroom noise intrusion has continued to evolve. The current ANSI recommendation for school design (ANSI S12.60-2002 R-2009)¹⁸ calls for a classroom environment with a noise background level of no greater than 35 dBA. This is significantly lower than the 45-dBA interior cited as usual in the *AIP Handbook* as amended by PGL 12-09.

While the ANSI standard is not yet codified in the IBC, it is worth noting since the recommendations of the ANSI standard have been implemented in a number of states, including Ohio, New Hampshire, New Jersey, Minnesota, and Connecticut. Other classroom acoustics standards and directives based on ANSI S12.60 are in use in the states of California, Washington, and New York as well as in the Philadelphia, Minneapolis, and Washington, D.C., school districts.

As the designated national standards entity, the ANSI recommendation will likely be the resource used in updates to the national building codes. In addition, the U.S. Access Board has proposed referencing ANSI S12.60 in the 2012 IBC. This standard may affect the sound insulation of schools if incorporated into the code for the renovation of existing buildings.

B. Modular Classrooms

Modular classrooms can be sound insulated, and several programs have done this. With many schools, a feasibility or justification study is done to test and design schematic treatments for the entire campus prior to a full commitment to treatment. During that process, additional considerations that are applied to treating modulars are:

- What is the extent of the design treatments needed to effectively sound insulate the structure?
- Is the structure considered a permanent part of the school facility, with a 10- to 20-year life span?
- What is the cost-benefit analysis, and will the treatments be cost-effective?

After these due diligence items are established, consult the FAA to determine whether the school project will be funded.

Unlike mobile homes, which have minimal construction and a temporary nature, modular classrooms are more permanent in construction. They are standardly built using 2x4 framing and are constructed similarly to a modular home. Modular homes that have been placed on permanent foundations have also been treated in residential sound insulation programs across the country. The only real difference is that the modular units are partially constructed in a factory rather than stick built on site. In addition to being built on a movable chassis, mobile homes have a much different construction, making upgrading the walls and ceilings to meet noise reduction properties of standard construction cost prohibitive and space consuming.

To sound insulate modular classrooms, they should be assessed as any other construction type by evaluating sound paths into the structure. If the walls and ceilings are a minimum ½-in.

¹⁸ ANSI, ANSI S 12.60-2002 R2009, Acoustical Performance Criteria, Design Requirements, and Guidelines for Schools.

GWB construction on wood studs/joists with a standard exterior sheathing, those walls and ceilings need only be treated if the level of exterior noise exposure is too high to achieve the desired interior noise levels. The possible treatments for these structures include:

- New windows,
- New doors,
- New accessible entry platforms,
- New HVAC systems,
- New GWB wall layer,
- New acoustical ceiling-tile ceilings, and
- Structural reinforcement to meet seismic loads.

5.3.4 Best Practice Recommendations: Public Buildings

1. Be aware that unlike residential structures, where a typology of architectural features can be determined, public buildings will be more likely to be unique in design and construction.
2. Many noise mitigation programs, in consultation with their ADO, adopt speech interference metrics as a guide to providing appropriate levels of sound insulation in classrooms, churches, and other noise-sensitive public spaces. The standard recommended by FICAN is to provide an interior learning environment with no greater than a 60-dBA noise level during the 95th percentile of the flights to eliminate speech interference.¹⁹
3. Remember that public buildings have larger spaces than houses, and the potential percentage impact of a lightweight ceiling/roof is great.
4. Working with public buildings requires a different level of communication and discussion than residential work.

There are many components to a successful nonresidential sound insulation project, but it is important to determine early in the process which governmental entities have jurisdiction over the project and what their distinctive requirements and approval processes are.

¹⁹ See note 4, Attachment 1, §812 (c)(3), Table 3, p. 1-9.



CHAPTER 6

Treatment of Historic Structures

The spirit and direction of the Nation are founded upon and reflected in its historic heritage. The historic and cultural foundations of the Nation should be preserved as a living part of our community life and development in order to give a sense of orientation to the American people.

— Section 1 of the National Historic Preservation Act

Acknowledging the architectural and historical character of significant buildings is an important part of a sound insulation program's ability to engender community goodwill. Further, sponsors of sound insulation programs are obligated per AIP grant assurances to certify that the project will "comply with all applicable Federal laws . . . as they relate to . . . the use of Federal funds for the project."¹ The National Historic Preservation Act of 1966 is one of the regulatory requirements airport sponsors certify compliance with when accepting AIP grant funding. Section 106 of the act specifically addresses the protection of historic properties. An understanding of the act and its associated regulations (particularly 38 CFR Part 800) is important not only to ensure that the sponsor is in compliance with grant funding requirements, but to ensure the preservation of significant historic resources that have meaning and value to the community.²

6.1 The Role of Section 106

The purpose of Section 106 is to identify historic properties potentially affected by federally funded projects and seek ways to avoid, minimize, or mitigate any adverse effects to them. The adverse effect usually associated with a sound insulation program is described by 36 CFR 800.5(a)(2)(ii):

Alteration of a property, including restoration, rehabilitation, repair, maintenance, stabilization, hazardous material remediation, and provision of handicapped access, that is not consistent with the Secretary's Standards for the Treatment of Historic Properties (36 CFR Part 68) and applicable guidelines.³

Specific to sound insulation programs, airport sponsors and the FAA need to comply with Section 106 and its associated regulation, 38 CFR Part 800, to take into account potential effects of sound insulation treatments on structures that are either listed in the National Register of Historic Places ("National Register") or meet eligibility criteria for listing in the National Register. The Section 106 process allows for review and consultation between project stakeholders and other parties with an interest in the effects of the project on historic properties. **This consulta-**

¹ Airport Sponsor Assurances, FAA, last modified March 2011, http://www.faa.gov/airports/aip/grant_assurances/media/airport_sponsor_assurances.pdf.

² 36 CFR Part 800 – Protection of Historic Properties (incorporating amendments effective August 5, 2004, Advisory Council on Historic Preservation, accessed November 2011, <http://www.achp.gov/regs-rev04.pdf>).

³ 36 CFR Part 800 – Protection of Historic Properties (incorporating amendments effective August 5, 2004, Advisory Council on Historic Preservation, accessed November 2011, <http://www.achp.gov/regs-rev04.pdf>).

tion should take place during the start-up phase of the project before the design and installation of sound insulation treatments begin.

6.2 Definition of *Historic*

The National Register Bulletin states that “[t]he quality of significance in American history, architecture, archeology, engineering, and culture is present in districts, sites, buildings, structures, and objects that possess integrity of location, design, setting, materials, workmanship, feeling, and association.”⁴ Of these various types of historic resources, sound insulation programs deal with buildings or groupings of buildings that individually or as a “district” (a group of buildings with similar architectural or historic characteristics) can be considered historic by local communities, states, or the federal government. Per AIP grant assurances, sound insulation programs need to determine if any of the structures that are eligible for treatment are considered to be historic. Per evaluation criteria established by the Secretary of Interior for listing in the National Register, a structure is considered eligible if one or more of the following criteria are met:

Criterion A. Buildings associated with events that have made a significant contribution to the broad patterns of U.S. history; or

Criterion B. Buildings associated with the lives of significant persons in our past; or

Criterion C. Buildings that embody the distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction; or

Criterion D. Buildings that have yielded, or may be likely to yield, information important in history or prehistory.⁵

Exceptions to the criteria: buildings with attributes noted in the following are not ordinarily considered eligible for the National Register:

- Buildings owned by religious institutions or used for religious purposes,
- Buildings that have been moved from their original locations,
- Reconstructed historic buildings,
- Buildings that are primarily commemorative in nature,
- Buildings less than 50 years old,⁶ and
- Buildings with insufficient integrity.

6.3 The Section 106 Process

The Section 106 process should be undertaken during the start-up phase of a sound insulation program to determine:

- If any of the buildings designated for sound insulation are historic,
- If sound insulation treatments will affect those historic properties, and
- If the effect of sound treatments is deemed adverse.

⁴“How to Apply the National Register Criteria for Evaluation,” *National Register Bulletin*, National Park Service, accessed November 2011, http://www.nps.gov/nr/publications/bulletins/nrb15/nrb15_2.htm.

⁵Adapted from “How to Apply the National Register Criteria for Evaluation,” *National Register Bulletin*, National Park Service, accessed November 2011, http://www.nps.gov/nr/publications/bulletins/nrb15/nrb15_2.htm.

⁶Adapted from “How to Apply the National Register Criteria for Evaluation,” *National Register Bulletin*, National Park Service, accessed November 2011, http://www.nps.gov/nr/publications/bulletins/nrb15/nrb15_2.htm.

Section 106 Overview

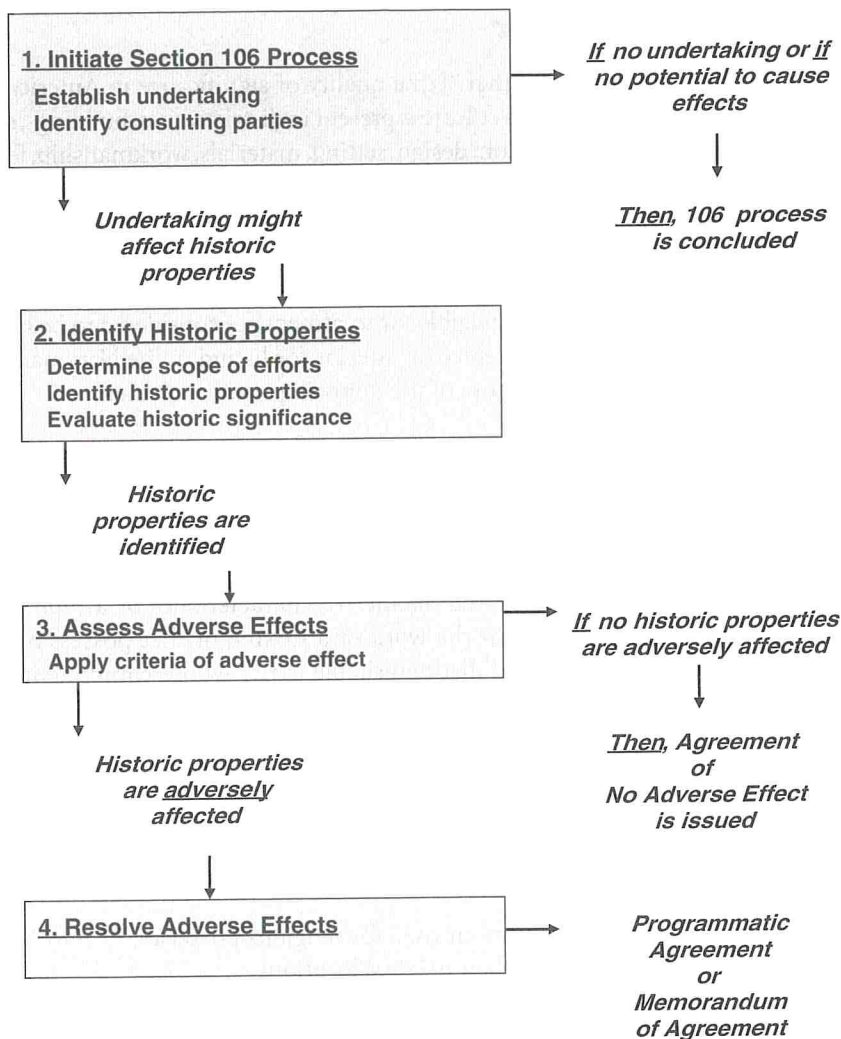


Figure 6.1. The four steps of the Section 106 process.

If adverse effects are determined, establish measures required to mitigate them.

As indicated in the process diagram shown in Figure 6.1, there are four distinct steps to the 106 process:⁷

1. Initiation of the 106 process and identification of participants,
2. Identification of historic properties,
3. Assessment of adverse effects, if any, and
4. Resolution of adverse effects: memorandum of agreement or programmatic agreement.

A brief description of each of the four steps follows.

⁷ Historic Preservation: Section I, Surface Transportation Board, accessed November 2011, <http://www.stb.dot.gov/stb/environment/HistoricPreservation/Section1.htm>.

6.3.1 Step 1: Initiation of the Section 106 Process and Identification of Participants

The responsibility for the Section 106 process lies with the FAA.⁸ However, this responsibility can be (and usually is) passed to the airport sponsor as the grantee of federal funds. Whether the FAA or the airport sponsor assumes responsibility for the 106 process, this party becomes the responsible agency for coordinating the 106 process and includes all stakeholders who will potentially be affected by the project. As a best practice, these consulting parties should include:

- Regional FAA project manager or point of contact,
- Representative(s) of the airport sponsor (airport owner/sound insulation manager/sponsor's consultant),
- State historic preservation officer (SHPO),
- Tribal historic preservation officer, if applicable,
- City historic preservation officer, if applicable,
- Representative(s) of native Hawaiian organization, if applicable,
- Representative(s) of national Advisory Council on Historic Preservation (ACHP), as required, and
- Representative(s) of local public historic preservation commission, if applicable.

The agency first determines whether it has an undertaking that is a type of activity that could affect historic properties. If it determines its undertaking is a type of activity that has no potential to affect historic properties, the agency has no further Section 106 obligations.

Note: An *undertaking* as defined by the 106 process refers to a project, activity, or program funded in whole or in part under the direct or indirect jurisdiction of a federal agency, including those carried out by or on behalf of a federal agency, those carried out with federal financial assistance, and those requiring a federal permit, license, or approval.⁹

6.3.2 Step 2: Identification of Historic Properties¹⁰

If the agency's undertaking could affect historic properties, the agency determines the scope of appropriate identification efforts and proceeds to identify historic properties in the area of potential effects (APE). The APE refers to the geographic area or areas within which an undertaking may directly or indirectly cause alterations in the character or use of historic properties, if any such properties exist. The APE is influenced by the scale and nature of an undertaking. For sound insulation programs, the APE is the geographic area that is within the program boundary.

The agency reviews background information, holds discussions with the consulting parties, seeks information from knowledgeable parties, and conducts additional studies as necessary. Districts, sites, buildings, structures, and objects listed in the National Register are considered; unlisted properties are evaluated against the Secretary of Interior's published criteria, in consultation with the SHPO. If questions arise about the eligibility of a given property, the agency may seek a formal determination of eligibility from the ACHP.

A Section 106 review gives equal consideration to properties that have already been included in the National Register as well as those that have not been so included but meet National Register criteria. If the agency finds that no historic properties are present or affected, it provides

⁸ See note 2.

⁹ 16 USC § 470w: US Code - Section 470W: Definitions, Find Law, accessed November 2011, codes.lp.findlaw.com/uscode/16/1A/II/C/470w.

¹⁰ See note 2.

documentation to the SHPO and, barring any objection in 30 days, proceeds with its undertaking. If the agency finds that historic properties are present, it proceeds to assess possible adverse effects.

6.3.3 Step 3: Assessment of Adverse Effects¹¹

The agency, in consultation with the other stakeholders, makes an assessment of adverse effects on the identified historic properties based on criteria found in the regulations. If they agree that there will be no adverse effects, the agency proceeds with the undertaking and any agreed-upon conditions. An agreement of no adverse effect (NAE) is documented to formally acknowledge this finding. If they find that there is an adverse effect, or if the parties cannot agree on the solution to reduce adverse effects, the agency begins consultation to seek ways to avoid, minimize, or mitigate the adverse effects.

6.3.4 Step 4: Resolution of Adverse Effects: Memorandum of Agreement and Programmatic Agreement

To resolve adverse effects, the agency confers with the consulting stakeholders. The ACHP may participate in consultation when there are substantial impacts to important historic properties, when a case presents important questions of policy or interpretation, when there is a potential for procedural problems, or when there are issues of concern to Indian tribes or native Hawaiian organizations. Consultation usually results in a memorandum of agreement (MOA) or programmatic agreement (PA), which outlines agreed-upon measures that the agency will take to avoid, minimize, or mitigate the adverse effects. In some cases, the consulting parties may agree that no such measures are possible but that the adverse effects must be accepted in the public interest.

6.4 Preparing Agreement Documents (NAEs, MOAs, PAs)

There are three types of agreement documents that record the outcome of the Section 106 process: NAEs, MOAs, and PAs.¹² It is important that every sound insulation program have the result of its 106 process recorded in one of these three documents. A brief description of each document follows.

No Adverse Effect. Given the number of structures that are typically treated in sound insulation programs, it would be highly unusual for there to be no historically significant structures or for none of the program treatments to result in an adverse effect. However, should this be the case, the finding of NAE, or declaration of measures the program will take to avoid adverse effect, is recorded in an NAE agreement signed by the FAA, SHPO, the airport sponsor, and, as relevant, the appropriate local public historic agency. The council is typically advised of the NAE and provided with supporting documentation that substantiates the finding.

Memorandum of Agreement. An MOA records the outcome of a 106 process where there is no reasonable alternative to the action causing the adverse effect and where the measures that can be adopted to reduce or mitigate the adverse effects are obvious and easily agreed on. In these cases, an MOA is appropriate and represents the best compromise to all consulting parties.

¹¹ See note 2.

¹² Excerpted from *Preparing Agreement Documents: How to Write Determination of No Adverse Effect, Memoranda of Agreement, and Programmatic Agreements Under 36 CFR Part 800*, Advisory Council on Historic Preservation, September 1989.

Programmatic Agreement. A PA is the preferred agreement document to use when there is a large and complex program that would require many individual requests for consultation of adverse effect and where making such requests will be inefficient. Treatment guidelines describing typical treatments and mitigation measures are usually part of a PA. The participants and signatories to a PA are almost always the FAA, SHPO, the airport sponsor, the local government historic agency, and the council.

Further information regarding these three agreement documents can be found in *Preparing Agreement Documents: How to Write Determination of No Adverse Effect, Memoranda of Agreement, and Programmatic Agreements Under 36 CFR Part 800*, issued by the ACHP.

6.5 Sound Insulating Historic Structures

6.5.1 Diversity of Historic Structures

The types of structures that are potentially historic cover hundreds of years of American history and a wide-ranging variety of architectural styles. Some of these styles, such as Pueblo, California Mission, Colonial, and Federal, are regional responses to cultural influences and construction techniques and materials that were unique to the geographic region in which they originated. Many different types of windows, doors, and wall and roof conditions were created in response to these same regional factors. The challenge of providing acoustical treatments and products appropriate to these diverse styles and material conditions is daunting but is necessary given the need to mitigate adverse impacts to historic properties.

6.5.2 Design Process and Limitations

The treatment guidelines developed for the PA must conform to the Secretary of the Interior's Standards for Treatment of Historic Properties. The Secretary of the Interior is responsible for establishing standards for all federally funded programs. The standards describe four separate treatment approaches: preservation, rehabilitation, restoration, and reconstruction. The Standards for Rehabilitation (36 CFR Part 67) are the most relevant to developing treatments for sound insulation programs. Rehabilitation is defined as:

the process of returning a property to a state of utility through repair or alteration which makes possible an efficient contemporary use while preserving those portions and features of the property which are significant to its historic, architectural, and cultural values.¹³

Three levels of treatment are described by the rehabilitation standards:

1. Protecting and maintaining. This generally involves the least degree of intervention and is preparatory to other work. For example, protection includes the "maintenance of historic materials through treatments such as rust removal, caulking, limited paint removal, and reapplication of protective coatings; the cyclical cleaning of roof gutter systems; or installation of fencing, alarm systems, and other temporary protective measures."¹⁴
2. Repair. Recommended "when the physical condition of character-defining materials and features warrant additional work. . . . Rehabilitation guidance for the repair of historic materials . . . begins with the least degree of intervention possible such as patching, piecing-in, splicing, consolidating, or otherwise reinforcing or upgrading them according to recognized

¹³The Secretary of the Interior's Standards for Rehabilitation, National Park Service, accessed November 2011, www.nps.gov/tps/standards/rehabilitation/rehab/stand.htm.

¹⁴Excerpted from, Anne E. Grimmer and Kay D. Weeks, *Secretary of the Interior's Standards for the Treatment of Historic Properties*, (Washington, D.C.: U.S. Department of the Interior, 1995), 63.

preservation methods. Repairing also includes the limited replacement like-for-like—or with compatible substitute material—of extensively deteriorated or missing parts of features when there are surviving prototypes. . . . Although using the same kind of material is always the preferred option, substitute material is acceptable if the form and design as well as the substitute material itself convey the visual appearance of the remaining parts of the feature and finish.”¹⁵

3. Replacement with new material. Sometimes required when “the level of deterioration or damage of materials precludes repair. . . . Like the guidance for repair, the preferred option is always replacement of the entire feature like-for-like, that is, with the same material. Because this approach may not always be technically or economically feasible, provisions are made to consider the use of a compatible substitute material.”¹⁶

Designing appropriate sound insulation treatments for historic buildings begins with identifying the character-defining features of the historic building that is being evaluated for treatment. Character-defining features include specific elements of the building evidenced in the architectural design, materials, and workmanship, and items that contribute to its historic feeling. Particularly important to sound insulation programs are character-defining features such as windows, doors, and roofs, and other exterior envelope features that may be affected by sound insulation treatments.

6.5.3 Historic Treatment Priorities

A strict application of the Standards for Rehabilitation and the three levels of treatment as discussed in the previous section suggests there are three options for sound insulation treatments of windows, doors, and other treatments visible from the public right-of-way.¹⁷

- Option one: maintain existing conditions.
- Option two: maintain and upgrade existing windows and doors.
- Option three: replace existing materials with acoustical products.

Option one, maintaining existing conditions, is not a viable option for sound insulation programs where noise infiltrates into the structure by virtue of deficiencies in the exterior envelope, with the greatest noise paths being windows and doors.

Option two, maintaining and upgrading existing windows and doors, can sometimes be an option depending on many factors, including location of the structure within the contour, conditions of the doors and windows, and the degree to which the windows and doors need to be acoustically improved in order to meet program acoustical goals. The program architect and acoustical consultant should consult closely to determine if treatments per option two are possible.

Option three, replacing existing materials, is the option most often pursued by sound insulation programs. As a practical matter, reducing noise levels by at least 5 dB and achieving an interior noise level of not greater than DNL 45 dB are often not possible without replacing existing windows and doors. It is important to note, however, that research needs to be done and care needs to be taken when specifying replacement window and door products.

¹⁵ Excerpted from, Anne E. Grimmer and Kay D. Weeks, *Secretary of the Interior's Standards for the Treatment of Historic Properties*, (Washington, D.C.: U.S. Department of the Interior, 1995), 63.

¹⁶ Excerpted from, Anne E. Grimmer and Kay D. Weeks, *Secretary of the Interior's Standards for the Treatment of Historic Properties*, (Washington, D.C.: U.S. Department of the Interior, 1995), 63.

¹⁷ Secretary of the Interior's Standards for Rehabilitation, California Department of Parks and Recreation, April 27, 2011, www.parks.ca.gov/pages/1054/files/santa%20clara%20stdsc.pdf.

Provision number 6 of the Standards for Rehabilitation states that when a historic feature needs to be replaced, “the new feature shall match the old in design, color, texture, and other visual qualities and, where possible, materials.”¹⁸

Note that some regional FAA offices have relaxed the requirement that a 5-dB NLR be achieved in some cases where the historic integrity of a structure would be irreversibly compromised by replacement of windows or doors.

PGL 12-09 does not mention whether an exception to the FAA’s stated acoustical goals (i.e., minimum 5-dB NLR improvement and interior noise level of not greater than DNL 45 dB) will be allowed if treatments required to meet these goals are prohibited by a PA or MOA. **Program sponsors and consultants are advised to consult with their local ADO before treating any historic structure(s).**

There are of course other acoustical treatments typical to sound insulation projects that can visually affect a historic structure. When planning for installation of mechanical and electrical equipment, rooftop vents, wall vents, chimney caps, and so forth, care should be taken to, where possible, place such equipment in locations that are not visible from the public right-of-way.

As noted in Section 6.4, MOAs and PAs typically include treatment guidelines that specifically describe the preferred options for rehabilitation, the process for reviewing and approving changes to character-defining features of historic structures, and the types of products that are permitted for upgrading and replacing historic materials. It is a best practice for every program to have worked with local, state, and, as necessary, national historic preservation agencies to prepare historic treatment guidelines. These guidelines act as the rulebook that defines what is and what is not appropriate for acoustical treatment, which can help avoid painstaking and expensive structure-by-structure reviews and misunderstandings as to what treatments are permissible and under what circumstances.

6.5.4 Building Codes

Historic structures can be exempt from complying with some aspects of the building code, but generally not those provisions that directly affect the health and safety of occupants. Building codes will often define which types of historic structures are exempt from certain code provisions. These exemptions typically apply to house-museum type structures and not those historic structures that are ordinarily eligible for listing on local, state, or national registers. A best practice for consultants and sponsors alike is to consult with the building officials who have jurisdiction over the program area to review which code provisions apply to the program’s historic structures.

One such health/safety code provision that is rarely exempted for historic structures is the requirement that any room used for sleeping purposes must have a minimum of one opening that can be used for emergency egress. When this opening is a window, the architect needs to ensure that the window meets the minimum size required by code. Often, meeting these minimum size requirements requires either changing the style of the window or its size. Both of these alterations can affect the historic appearance of the structure, and such changes need to be carefully considered. It is also important to note that some building codes require at least one egress door to meet minimum size requirements as well. These situations present the same need to carefully consider the style and material of the new door if replacement is required.

¹⁸ Technical Preservation Services, *Interpreting the Standards, Number 23*, (Washington, D.C.: National Park Service, 2001).

Designers and sponsors need to be aware of the impacts that energy codes presently have and will increasingly have on door and window products. As codes become increasingly stringent in their requirements for energy performance, finding window and door products that are appropriate to treat historic structures will become more difficult. For example, low-E glass is now almost universally required to meet the energy requirements for windows. However, most historic commissions do not allow it to be used in historic structures due to its non-historic appearance. (Many types of low-E glass have a slight off-color tint and reflective qualities.) It can be expected that the sometimes competing requirements of energy efficiency and preservation of architectural features of historic structures will increasingly need to be considered when specifying products and treatments for sound insulation programs.

6.6 Best Practice Recommendations: Treatment of Historic Structures

1. To ensure a thorough and appropriate consultation between project stakeholders and other parties with an interest in the effects of the project on historic properties, undertake and complete the Section 106 process during the start-up phase of the project, before the design and installation of sound treatments begin.
2. Be sure to include all relevant consulting parties, as listed in Section 6.3.1.
3. Record the result of the 106 process in an NAE, MOA, or PA, as appropriate.
4. Treatment guidelines developed for a PA must conform to the Secretary of the Interior's Standards for Treatment of Historic Properties.
5. Work with local, state, and, as necessary, national historic preservation agencies to prepare historic treatment guidelines.
6. Consultants and sponsors alike should consult with building officials who have jurisdiction over the program area to review which code provisions apply to the program's historic structures.
7. Consult with the local FAA ADO to determine if an exception to the FAA's stated acoustical goals will be allowed if treatments required to meet these goals are prohibited by a PA or MOA.
8. Be aware of the sometimes competing requirements of energy efficiency and preservation of architectural features of historic structures when specifying products and treatments for sound insulation programs.

HVAC and Ventilation Strategies

7.1 Introduction

The primary goal of FAA-funded SIPs is to reduce the adverse impacts of airport-related noise that negatively affect so-called sensitive receptor building types such as residences, schools, churches, and others, as described in Chapter 2 of these guidelines. A core strategy of acoustical treatments is to seal noise paths into the habitable portions of the affected buildings and provide mechanical systems to accommodate the comfort and health of the occupants. Generally, exterior envelope treatments involve installation of acoustical windows and doors that result in a structure that is tightened against both sound and air infiltration. Following treatment, structures typically require HVAC systems to condition and ventilate the space for occupancy. Conditioning is not limited to heating and cooling—it also includes humidity control, ventilation air, exhaust air, and indoor air quality. As a result, SIPs are multidisciplinary and require knowledge from many design professionals, construction trades, standards writing organizations, and code compliance agencies.

It is recognized by the design professionals involved in specifying SIP treatments that changes to the building envelope, reduction of intrusion points, and lowered infiltration can affect occupant health and comfort. Significant building envelope changes typically require the addition of mechanical ventilation to maintain indoor air quality, proper moisture levels, and comfort. Any replacement products and treatments required to meet program objectives must meet the current governing construction standards, energy standards, federal and state code compliance standards, Title 24 in California, and any local codes or requirements that apply. Please note that this guide does not replace professional guidance from design professionals or engineers.

7.2 Regulatory Environment

7.2.1 Code Compliance

Building codes specify the minimum acceptable design and construction criteria for public safety and enduring functionality. The main purposes of building codes are public health, safety, and general welfare as related to the construction and occupancy of buildings and structures. Building codes become law in particular jurisdictions when formally enacted by the appropriate governing authority.

Design professionals are some of the primary users of building codes, using the criteria in the design process to ensure conformance to the minimum standard, or, as necessary, designing to a more stringent standard that may be required for particular projects. It is necessary for all design personnel to be familiar with the codes related to their work. In addition, building codes affect all aspects of construction involving environmental scientists, developers, contractors and

subcontractors, manufacturers of building products and materials, facility managers, building owners, occupants, and inspection officials.

The International Code Council (ICC) publishes the International Building Codes, used by most jurisdictions in the United States. They have 14 sets of codes, including the IBC, the International Residential Code, the Existing Building Code, the International Fire Code, the International Energy Conservation Code (IECC), the International Plumbing Code, and the International Mechanical Code (IMC).

There are instances where states and local jurisdictions choose to develop their own building codes. In the past, all major cities in the United States had their own building codes; however, due to the increasing complexity and cost of developing building regulations, virtually all municipalities in the country have chosen to adopt model codes instead, commonly based on the IBC.

The design process defines the code compliance needed for any project. Sometimes it is difficult to determine the hierarchy of code enforcement, but traditionally the local code enforcement agency is the final arbiter. In most cases, SIPs will use the highest jurisdictional standard as the minimum acceptable parameters for design solutions. Since state, county, and, in many cases, city code requirements will vary, it is critical for SIP teams to investigate the presiding requirements for each project or individual site. SIPs will receive their final construction approval from local county or municipality code enforcement inspectors.

Energy Codes. National building codes and the air conditioning, refrigeration, and ventilation industry standards recognize the impact of residential and commercial buildings on national energy usage and future planning. As a result, building codes are requiring greater efficiency with each new revision. Efficiency requirements affect both the construction of the building envelope and the equipment that conditions and services the occupied spaces. States set the minimum standards that municipalities and counties use and administer within their jurisdictions. Many states have adopted the ICC's model code and require buildings to be constructed in accordance with ICC's family of codes, including the IBC, the IMC, and the IECC. In addition to the ICC, the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) and other industry associations provide significant information regarding design criteria. Newer standards and codes have an increased focus on sustainability and energy-conscious building construction. LEED in particular is receiving wide-ranging approval and implementation. A new voluntary International Green Construction Code (IgCC) has been promulgated to provide guidelines on sustainable design and construction.

The IECC and the ASHRAE Standard 90.1, Energy Standard for Buildings Except Low-Rise Residential Buildings, are the major references for energy compliance. The IECC is a model energy code, but it is written in mandatory, enforceable language, so that state and local jurisdictions can easily adopt the model as their energy code. These codes take into account local climate, geography, and other regional factors. The significance of energy standards affects the type and ratings of aperture treatments and mechanical equipment used to complete SIPs. Any upgraded or replaced equipment must meet or exceed the locality's current standard. Changing energy standards, combined with locality requirements, may cause significant cost variations and affect SIP treatments. The resulting projects will necessitate the SIP manager's diligent involvement to maintain productivity, expenditure, and schedule control.

7.2.2 Standards for Ventilation

To understand ventilation requirements, a few concepts need to be defined to properly understand the regulations. The regulations described in the following refer to *air changes per hour*, *fresh air*, *outdoor air*, and *air exchange rate*. These terms are not interchangeable in the lexicon of HVAC

design, and the terms are often redefined as the standards evolve. The term *air changes per hour* (ACH) is changing to *air change rate* (ACR) and is a volume measurement for air moving from a space measured against the total volume of the space. There is a separate standard, ASHRAE Standard 136-1993 (RA 2006), A Method of Determining Air Change Rates in Detached Dwellings, for calculating the ACR that works in conjunction with the other ventilation standards. The term *fresh air* is no longer used to mean air pulled directly from the outside. The HVAC industry now refers to *fresh air* as *outdoor air*, with the understanding that in many areas of the country, the air being introduced from outside is not fresh due to airborne pollutants. The term *air exchange rate* is now referred to as *ventilation* and is the process of supplying outdoor air or removing indoor air, or both (see Section 7.3.4 on pressurization for full discussion).

Because there are sometimes years between the posting of a new standard and the ratification by other agencies, there are some changes that have not reached the local level of code enforcement but will in the future. One such example is the term *ventilation*, which in ASHRAE Standard 62.1-2007, Ventilation for Accessible Indoor Air Quality, was defined as “the process of treating air to meet the requirements of a conditioned space by controlling temperature, humidity, and distribution.” The 2010 update to the standard provides the definition, “ventilation (is) the process of supplying outdoor air to or removing indoor air from a dwelling by natural or mechanical means.” **Therefore, for the purpose of this document, the term *ventilation* is intended to mean the process described in the latest standard. This point is very important since most SIP treatments will include ventilation air.**

A. International Residential Code

Residential sound insulation treatments start with the IRC as the minimum standard for residential ventilation. Section 303.1 of the IRC-2012 states that:

Habitable rooms shall have an aggregate glazing (window) area of not less than 8% of the floor area of such rooms.

1. Natural ventilation shall be through windows, doors, louvers, or other approved openings to the outdoor air. . . .
2. The minimum open area of a window to the outdoors shall be four percent of the floor area being ventilated.

This standard allows for the following exception:

Windows are not required to be operable if they are not required for emergency egress and a mechanical ventilation system is present that meets the conditions of Chapter 15 of the IRC-2012.

However, the acoustical improvements provided by SIPs require that windows and doors be kept closed to provide the sound insulation benefits. As such, FAA guidelines acknowledge the need for ventilation air and stipulate the provision of air-change-compliant designs. IRC-2012 and all ICC model codes structure their regulations on the recommendations of industry groups such as ASHRAE. To develop these guidelines for SIPs, ASHRAE standards provide the basis for recommendations.

B. ASHRAE Ventilation Standards

In response to increasing concerns regarding residential indoor air quality, ASHRAE developed a new standard for ventilation, ASHRAE 62.2, Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings. Added to the standard are two appendices to clarify questions regarding existing buildings and outline addenda. The standard addresses the need to control indoor air quantity and quality via mechanical systems rather than infiltration and operable windows.

The standard provides basic recommendations, sometimes adopted by code officials as requirements. It is important to remember that local codes have precedence over any standards

unless otherwise stated in the local codes. Additionally, there is often a multiyear delay between ASHRAE publication and local adoption. The removal of indoor air pollution can be addressed by three principal methods:

- Whole-house ventilation is intended to dilute unavoidable contaminant emissions from people, from materials, and from background processes.
- Local exhaust is intended to remove contaminants from those specific rooms (e.g., kitchens and bathrooms) that, because of their design function, are expected to contain sources of contaminants.
- Other source control measures are included to deal with those sources that can be reasonably anticipated to be found in a residence¹ [such as from combustion appliances and garages].

Section 4 of the standard provides tables for whole-house ventilation rates and equations for calculations based on square footage of living space and the number of bedrooms.

Ventilation is best accomplished by exhausting indoor air and supplying outdoor air, possibly through an energy (or enthalpy) recovery ventilator (ERV) or a heat recovery ventilator (HRV). It is important to remember that air cannot be moved into or out of a structure without pressurization changes. Therefore, it is necessary to have a means to relieve building pressure if outdoor air is forced in. Bathroom exhaust fans with a low-speed continuous-operation mode or intermittent operation of a kitchen exhaust hood are inexpensive solutions that can meet ventilation rate objectives but will be an issue for occupants. Occupants will turn off or disconnect fans that run continuously to stop the noise, eliminate the energy consumption, or stop drafts, regardless of the impact on the overall system objectives. Outdoor air intakes ducted to return-side HVAC distribution systems can be used as a ventilation air solution. Air distribution can be managed with a simple switch that controls operation functions such as intermittent (during seasons that require minimal heating and cooling), continuous (for continuous operation during high occupancy), or off. The standard also takes into account differing climates. Some mild climates do not require whole-house ventilation (though the assumption is that the windows are operable and used). Extremely cold, hot, or humid climates, as defined by the standard (see ASHRAE 62.2, Section 8), have limitations on ventilation rates so that conditioning systems can maintain proper comfort.

It is important to note that ASHRAE 62.2 does not address ventilation systems as a requirement for providing temperature and humidity control (i.e., comfort cooling or heating); that information is contained in ASHRAE Standard 55-2010, Thermal Environmental Conditions for Human Occupancy. Ventilation systems are additionally not designed as indoor air quality (IAQ) systems, even though they often contain limited filtration.

C. FAA AIP Guidance

The FAA's *AIP Handbook*, Chapter 812, as replaced by PGL 12-09, acknowledges central air ventilation systems as a noise insulation measure if the structure does not already have a central air ventilation system.² It further acknowledges that "the sponsor may recommend an air-conditioning system in lieu of ventilation only."³

Note: It is important to ascertain whether new or existing air conditioning systems provide supplementary outdoor air to meet ASHRAE requirements. Older and many current residential air conditioning systems are not typically designed to provide outdoor air. Therefore, homes with existing ducted air conditioning systems will need to be inspected to determine if they provide outdoor air. Introduction of outdoor air into the existing system will need to be reviewed for humidity, air quality, and thermal impact to the system.

¹ ASHRAE 62.2-2010, Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings, Foreword, p. 2.

² U.S. DOT, FAA, PGL 12-09, August 17, 2012, Attachment 1, §812 (c)(1), Table 1 p. 1-4.

³ U.S. DOT, FAA, PGL 12-09, August 17, 2012, Attachment 1, §812 (d), Table 4 p. 1-13.

Table 7.1. Ventilation air requirements (ASHRAE 62.2-2010).

Floor Area (ft ²)	Bedrooms (cfm*)				
	0–1	2–3	4–5	6–7	>7
<1500	30*	45	60	75	90
1501–3000	45	60	75	90	105
3001–4500	60	75	90	105	120
4501–6000	75	90	105	120	135
6001–7500	90	105	120	135	150
>7500	105	120	135	150	165

* cfm of infiltration applies to all numbers in chart.

Table 7.1, taken from ASHRAE 62.2-2010, states the ventilation rates for some typical dwelling sizes and is by no means exhaustive or correct in every instance. Full examination of the ASHRAE standards is required to set up specific projects; they include 136-1993, 119-1988, 55-2010, and 62.2-2010. As an example, 62.2 is a good starting location for calculations.

In addition to Table 7.1, Section 4.1.3 of ASHRAE 62.2-2010 discusses an infiltration credit that is allowed on homes that were constructed prior to January 2010, when the newest standard was adopted. The credit is for infiltration with a value of 2 cfm per 100 ft² of a dwelling. Table 7.1 assumes that this amount [(2 cfm)(square feet of conditioned space/100)] of infiltration will occur in addition to any mechanical ventilation in homes that are not extraordinarily treated against infiltration (i.e., standard building stock). It may be necessary to increase the mechanical ventilation rate of a home that has extraordinary treatments such as those provided by SIPs. (This is because the assumed infiltration rate built into the table may not occur.) The only true way to know the acceptable measures to undertake is to perform actual testing, such as blower-door tests, on each structure.

Whole-house ventilation systems discussed in the *AIP Handbook* are conceived as comfort systems, where air is filtered, conditioned, or partially exchanged with outdoor air. Calculating the design differences between the two criteria reveals that the previous FAA goal⁴ (now superseded by ASHRAE) of two ACH (48 air changes per day) would far exceed the new ASHRAE IAQ standard and increase operational costs for building owners. The following is an example in compliance with ASHRAE 62.2-2010 for a standard-construction, stick-built, 1500-ft² dwelling with 8-ft ceilings, two to three occupants, and 45 cfm of continuous exhaust:

- Total cubic feet of air in the dwelling: $1500 \text{ ft}^2 \times 8 \text{ ft} = 12,000 \text{ ft}^3$
- Total ventilation per the standard: $45 \text{ cfm} \times 60 \text{ min/hr} \times 12 \text{ hr/day} = 32,400 \text{ cfm per day}$
- Total air change rate: $32,400/12,000 = 2.7 \text{ ACR per day}$

It is clear that the cost for ventilation can be substantial. For a ventilated home of this size to meet the ASHRAE standard, all the air would need to be replaced 2.7 times a day. The requirement to heat or cool this air can be offset by the use of an ERV [discussed in Section 7.7.2 (D)]. It is a best practice recommendation of these guidelines to use the most current ASHRAE standard for ventilation as the policy for SIPs, even if it is more stringent than standards the local jurisdiction has adopted. At the time of this publication the current standard is 62.2-2010.

⁴U.S. DOT, FAA, Report No. DOT/FAA/PP-92-5, *Guidelines for the Sound Insulation of Residences Exposed to Aircraft Operations*, October 1992, §3.5.4.1, p. 3-45.

PGL 12-09 stipulates that plans and specifications must “conform to the local building code.”⁵ Local building codes vary considerably depending on location. For a program that has a national scope and is trying to achieve some measure of consistency in treatments, it is not unusual to adopt standards higher than those set at the local level. The federal government has taken a leadership position in designing and constructing projects in a manner that is energy efficient. ASHRAE standards for designing ventilation and air conditioning systems conform to this intent, but these standards are not uniformly adopted across the country. Some jurisdictions take several years to become up to date with new standards. Restricting treatments to the lower standards found in some local codes will reduce the increased energy efficiency available to sound insulation projects. Program sponsors and consultants are advised to consult with their local ADOs for further clarification.

D. Makeup Air

As mentioned previously, ventilation air will come from somewhere, whether it is through controlled mechanical systems or from infiltration through existing roofs, floors, walls, and their openings. SIPs aim to control the source of ventilation air. Air and noise will make it into the house through the path of least resistance. It is undesirable for the unintended path to be from unconditioned crawl spaces, attics, wall sections, doors, windows, or other penetration points. As much as possible, the path of outside air should be through the ventilation system. The FAA requirement for “continuous positive ventilation air” is a good idea as long as it is controlled and has a suitable intake point. The location for intake grills needs to be selected carefully to prevent the intake of air from areas prone to dust, dirt, or other contaminants. Intake louvers should be mounted high enough on the wall to avoid dust and ground clippings from mowing operations, far enough from exhaust systems to prevent recirculation, and distant from combustion gas exhaust as specified in applicable building codes. It is also better for the occupants if the ventilation air passes through some filtration.

7.2.3 Best Practice Recommendations: Code Compliance

1. Use the highest jurisdictional standard as the minimum acceptable parameters for design solutions. Investigate the presiding requirements for each project or individual site.
2. Use the most current ASHRAE, IECC, IBC, and other jurisdictional standards for design of HVAC systems. Use the most current ASHRAE standard for ventilation as the policy for SIPs, even if it is more stringent than standards the local jurisdiction has adopted.
3. Specify an outdoor air component for residential air conditioning units in order to comply with AIP guidance to provide residences with outdoor air changes.

7.3 Residential Indoor Air/Environment Quality

7.3.1 Sealing of Homes for Air Infiltration

IAQ is a significant issue that must be addressed as part of the design of sound insulation treatments. The reduction of infiltration and naturally occurring ventilation rates can intensify the effects of indoor air pollutants. Pollutants are chemical, physical, and biological—specifically,

⁵See note 2. Attachment 1, §812 (c)(1), p. 1-5.

radon, molds and allergens, carbon monoxide (CO) and carbon dioxide (CO₂), volatile organic compounds (VOCs), and other airborne contaminants that become trapped and recirculated in homes. The resultant lower ventilation rates, infiltration rates, and changes to indoor contamination are not specific to SIPs but rather are issues that need to be addressed in any structure with a tight exterior envelope.

A. Background

In a study conducted in the Midwest, blower-door testing established a baseline infiltration rate for each representative home before any project-related sealing or insulating was performed. Blower-door testing pulls a small negative pressure on a home using a doorway-mounted blower assembly, and simultaneously tracks airflow measurements and differential pressure. The study's measurements supplied researchers with a close approximation of natural infiltration. Results showed that newer homes (no date available) were sounder—that is, they had less measurable airflow at equivalent pressures than older homes. With measurements in hand, the necessity to address reduced infiltration resulted in the development of criteria to ensure that minimum ventilation air was included in the treatments, along with measures to ensure sufficient combustion air and venting for fuel-burning appliances. It is important to remember that combustion air is not part of ventilation air and must be considered separately. ASHRAE weighed in on the subject:

Residential ventilation was traditionally not a major concern, because it was understood that between operable windows and envelope leakage, people were getting enough (outside) air. In the quarter of a century since the first oil crisis, houses have become more energy efficient. At the same time, the materials and functionality of houses have changed in response to people's evolving needs. People are also becoming more environmentally conscious, not only about the resources they consume but also about the environment in which they live. These factors contribute to an increasing level of public concern regarding residential indoor air quality and ventilation. Where once there was an easy feeling about the residential indoor environment, there is now a desire to define levels of acceptability and performance.⁶

ASHRAE produces a standard for use in achieving good indoor air quality, ASHRAE Standard 24-2008, Ventilation and Indoor Air Quality in Low-Rise Residential Buildings. The purpose of the standard is to provide information for good air quality and “provide information relevant to ventilation and IAQ on envelope and system design, material selection, commissioning, and installation, operation and maintenance.”⁷ Filtration is one of the biggest issues for IAQ; therefore, ASHRAE continues to increase filtration recommendations.

B. Combustion Air

Combustion appliances can be deadly sources of CO if not properly maintained or vented, especially for non-vented space heaters, wood stoves, and open fireplaces. Proper installation of fuel-burning appliances is addressed in the National Fuel Gas Code and the IRC and is therefore not part of ASHRAE Standard 62.2. The standard does not cover the proper operation and maintenance of existing combustion appliances assumed to be operating properly. However, in SIPs that affect the construction and permeability of a structure, it is important that the design team recognize the combustion air requirements of existing equipment. In addition, if electric HVAC equipment inside the home is replaced by an SIP with fuel-burning equipment, provisions will need to be made to bring combustion air to the location of the new equipment.

⁶ ASHRAE 62.2-2003, Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings.

⁷ ASHRAE Standard 24-2008, Ventilation and Indoor Air Quality in Low-Rise Residential Buildings. Section 1.2.

7.3.2 Testing for Indoor Environmental Quality

A. SIP Blower-Door Testing

A thoughtfully planned SIP can address indoor air quality concerns for sponsors and building owners. For the most part, the solutions to tightness issues are not overly complex or expensive. Sampling and analysis of homes to establish baseline conditions can be instituted when developing design solutions and program policies. Similar to acoustical testing before and after construction, this sampling would strive to achieve designs applicable to the specific housing stock and conditions for each community, thereby avoiding repetitive and expensive house-by-house testing. A best practice recommendation is to test and inspect existing mechanical and ducting systems when they are to be reused.

Blower-door testing (see Figure 7.1) is used to provide empirical data on a structure's infiltration rate. Blower-door testing can measure the building's negative pressurization when exhaust fans are operating. The measurements obtained through this type of testing can help determine the potential for back-drafting of combustion appliances, the overall infiltration of a structure, and the integrity of any existing HVAC systems. It can also be used as a base for a particular dwelling type within a given area if ASHRAE has no existing suitable data.

B. Existing Duct Pressure Testing

Duct pressurization tests of any existing ductwork will help determine the need for additional air volume or treatment of ducts. There is great potential for reduction in the required amount of outside air reaching occupants and for loss of energy efficiency into attics or other unconditioned space from leaky ductwork. SIPs are advised to incorporate this testing as part of premodification design.



Figure 7.1. Blower-door test equipment.

7.3.3 Indoor Air Pollution

Indoor air pollution is created by building materials, furnishings, wall and floor coverings, and occupants. Buildings generate pollutants from plastics and synthetic fabrics that off-gas VOCs, combustion appliances that are poorly adjusted or vented, plumbing and building envelope leaks that lead to mold growth, or dust from multiple sources, including ones that may contain asbestos or lead. Indoor pollution originates from common household sources such as cleaning products, hobby materials, smoking tobacco, cooking odors, pet dander, odors from people, and any constituent of air that reduces acceptability. Even sources and products from outside migrate indoors, such as radon, pesticides, car exhaust, and myriad outdoor pollutants.

Indoor pollution can be controlled by reducing pollution at the sources and by diluting the indoor air with outdoor air. Some pollution may be controlled by eliminating the source from the start by selecting nonpolluting cleaners, smoking outside away from building inlets, and adjusting improperly functioning appliances. Pollutants such as off-gassing construction materials are not as easily controlled once the building is constructed. Purchasing furnishing and coverings made from natural materials may reduce out-gassing. Reducing or eliminating behavior-caused pollution should always be a first strategy for reducing indoor air pollution. Properly ventilating a building is the critical second step since human behavior devised to reduce pollution will vary and behavioral change will have little effect on building-generated pollution.

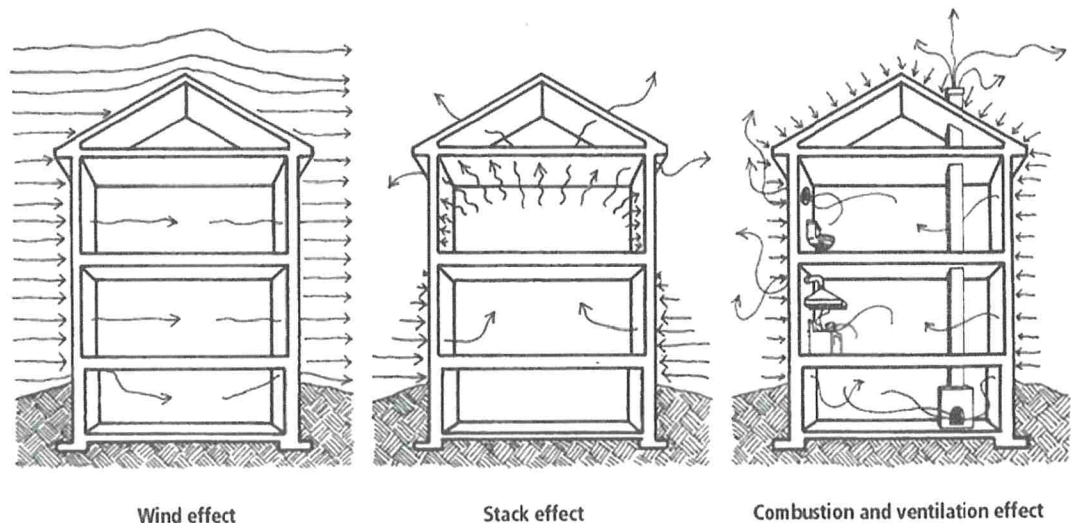
Ultraviolet (UV) lights, which have been used in hospitals for years, have moved into the residential market. UV light is powerful as a measure for defeating bacterial and microbial growth in air handlers and moist areas within HVAC systems. These systems require switching to prevent exposure to people, but the systems normally come with a door kill switch as part of the package. One of the newer systems features a sweeping UV light that prevents overexposure to internal parts.

Filtration is another method for eliminating some forms of indoor contaminants. Filters range in efficiency and cost, from the very basic throwaway from the local hardware store to the very costly HEPA, electronic, or 90%+ efficiency pleated media. In some cases, combinations of these filtration methods are used. No matter the method for filtration used to protect equipment and people, there are maintenance considerations. Filters must be accessible and removable, and possibly be cleanable. ASHRAE is preparing several addenda to 62.1 and 62.2 for clarification of filtration initiatives.

7.3.4 Pressurization

Mechanical equipment can cause pressurization differences within buildings. Negative pressures within the building envelope can prevent flues and furnaces from operating properly, allowing combustion gases to back-draft into the house. Even small pressure differences can push humid air through leakage paths in the building envelope, allowing condensation to form within walls and ceilings. Pressurization must be taken into account when designing and providing a ventilation system. The design requires more stringent duct sealing and leakage consideration if the mechanical equipment or ducting is outside the building envelope since untreated outdoor air, moisture, or other contaminants may be pulled into the airstream.

Open windows and infiltration historically provided sufficient air changes in residential dwellings. Figure 7.2 shows a few typical infiltration patterns. Open windows obviously create breaks in the building envelope and allow free exchange of air and noise. SIPs provide windows and doors with low rates of infiltration. These windows must be kept closed to achieve FAA goals for noise reduction. Infiltration involves more than just windows and doors and is determined using a variety of factors, including average indoor temperature, degree-day measurements, average wind conditions, and average building envelope construction.



Courtesy of the Office of Energy Efficiency (OEE) Natural Resources Canada (NRCAN).

Figure 7.2. Typical infiltration patterns.

According to research done by the Lawrence Berkeley Laboratories at the University of California, most housing stock in the United States is relatively leaky.⁸ (*Leaky*, by loose definition, is where infiltration exceeds the current ASHRAE Standard 119 for a particular class of home or geographical area.) When existing test homes were upgraded, intending to meet the standards for new construction homes, the homes were still leaky. ASHRAE Standard 119, Air Leakage Performance for Detached Single-Family Residential Buildings, calculates and tabulates the average leak rates for homes in hundreds of geographical areas within the United States. Although the composite average leak rate based on the tables is approximately 140 cubic ft/min, each geographical area must be considered individually. There are two methods to determine whether a structure complies with the standard for a given area: the first is to perform blower-door testing, and the second is to measure and perform the complex calculations listed in the standard.

Without testing to specifically measure a structure's infiltration rate, it can be assumed, based on ASHRAE 119, Section 4, Paragraph 2, that houses in known areas meet the standard for that location. After sound insulation treatments are installed and the major noise and air paths are sealed, the structure loses permeability. Since the post-treatment infiltration rate is now lower than the standard, infiltration cannot be relied on to consistently provide appropriate air exchanges. As a result, mechanical systems must intake outside air to fulfill ASHRAE 62.2-2010 requirements. ASHRAE 119-1988 states:

Although ASHRAE Standard 62.2 is to be considered as the reference for determining the sufficiency of ventilation (outdoor air), Appendix Table B.1a can be used to help estimate the contribution of infiltration in meeting ventilation requirements.

For structures in (the first three) classes, infiltration will almost never be sufficient to achieve adequate indoor air quality; specific mechanical ventilation will probably be required at all times (in which the windows are closed). For structures in (the next set of classes), infiltration may or may not be sufficient, depending on circumstances; mechanical ventilation may be required in some cases, but existing intermittent mechanical ventilation (i.e., bathroom/kitchen exhaust fans) may be sufficient. For structures in (the final classes), infiltration will normally be sufficient to meet ventilation requirements; additional mechanical ventilation will usually not be required.

⁸ Max Sherman and Nance Matson, *Residential Ventilation and Energy Characteristics*, Nance Lawrence Berkeley Laboratory, 1997.

It is important to remember that when infiltration is the key mechanism for supply ventilation, window opening during periods of low driving forces (wind, temperature differential, or humidity differential) will be necessary for adequate indoor air quality. Even if the average ventilation rate over the season is adequate to supply all ventilation needs, extended periods of low temperature difference may not supply sufficient ventilation. Thus for all leakage classes and in all climates, there will be times when infiltration is insufficient to meet ventilation requirements unless natural ventilation (i.e., window opening) or mechanical ventilation is used to augment the infiltration.⁹

7.3.5 Best Practice Recommendations: Indoor Air/Environment Quality

1. When considering ventilation solutions, such as in relation to continuous venting via bathroom or kitchen fans, recognize the role occupants play—specifically, the possibility of tenants shutting off equipment, to the detriment of planned ventilation.
2. Where required, install combustion air ducting and CO detectors to deal with the potential impact of combustion appliances as sources of CO.
3. Test existing building air infiltration and ducting system leakages to facilitate proper system design.

7.4 Evaluating Existing Residential Systems

7.4.1 Standard Types of Residential HVAC Systems

HVAC systems are as complex and varied as the homes and buildings they service and the geographical locations in which they are built. Buildings can be heated by straight electric strip heaters like baseboard heaters, radiant heat coils embedded in floors or ceilings, or strips in an air handling system. (Straight electric heat is the least desirable, most expensive choice to operate.) Buildings can also be heated by boilers that operate with electricity (expensive), natural gas, liquefied petroleum (LP) gas, fuel oil, or other fuel-burning appliances that hydronically transport heated water or steam to the conditioned space. Fuel-burning appliances are not limited to hydronics; indirect combustion in furnaces warm a heat exchanger that then heats the occupied space. Air conditioning is limited to two basic types: direct expansion and chilled water. Direct expansion is a system where refrigerant is used to carry heat between the condenser and evaporator and is typically used on smaller systems (most residential systems). Chilled water systems involve a chiller that produces cold water and a piping system that moves water to air handlers equipped with water-based heat exchangers; they are typically for commercial systems. There is some crossover of chilled water systems to residential, but it is rare. Both systems require air to move over the heat exchangers to condition the occupied space.

Air movement is a common component of nearly all HVAC systems. Therefore, it is necessary to have a method to move air through the temperature-producing sections of the system. To put it simply, there generally needs to be a primary mover (blower) and a distribution (duct) system.

As a part of the design of treatments for SIPs, existing systems need to be evaluated for viability and sizing. Additionally, existing systems need to be examined to determine their compatibility with current energy standards. Given the comprehensive nature of SIPs, the reduction of infiltration, and the installation of some sort of forced outdoor ventilation, few existing ventilation and

⁹ ASHRAE 119-1988 (RA2004), Air Leakage Performance for Detached Single-Family Residential Buildings, Ventilation Recommendations, p. 8.

distributions systems will be adequate. This typically means, at a minimum, equipment replacement, and at a maximum, a complete reengineering of the building's HVAC system.

Duct or distribution systems vary by size, material, and location. The systems listed in the following illustrate some of the variances in the equipment that are used in HVAC systems.

A. Outdoor Air Ventilation

Fresh air ventilation, currently known as *outdoor air ventilation*, is one method of improving interior conditions in occupied spaces. Outdoor air ventilation is different from natural ventilation because it is accomplished by mechanical means as opposed to simple pressure differential. It is uncommon to have distribution systems specifically for ventilation air in homes except in northern or low-humidity, temperate climates where air conditioning is uncommon or unneeded.

B. Central Heating: Furnaces

One of the most common residential systems is the centralized system. Central systems offer distribution to all conditioned living spaces and a ducted centralized return of air to the air handler or furnace. Forced-air furnaces using fossil fuels are popular central systems in colder climates.

C. Heat Pumps and Split Systems

Heat pumps, or reverse-cycle air conditioners, are central air conditioning systems that use a reverse cycle to heat. Using an air conditioner in this way to produce heat is significantly more cost-effective than electric resistance heating. Resistance heating is typically used as a backup for heat pumps. There are limitations in the geographical climate regions where heat pumps are most effective. A heat pump is basically a heat transfer machine, conveying heat from the indoors to the outdoors in the cooling season and vice versa in the heating season. The issue is that there is limited heat available to transfer when the outdoor temperature drops sufficiently. At some point, the outdoor section will not pick up enough heat to increase the indoor temperature, and some form of supplementary system will need to be used. Split systems are systems where the air handler and the condensing section are not assembled into one unit like package units.

D. Package Units

Many configurations of package units are available from the major manufacturers. Packaged units can be electric heat pumps, strictly air conditioners, or gas furnace/air conditioner combinations. The main consideration is that there is no need for an interior air handler. They can be ground-mounted, platform-mounted, or roof-mounted. Roof-mounted package units are typically used in commercial buildings. Many years ago, package units made the transition to the residential market. Rooftop locations provide free flow of air for unit operation and decrease vandalism. There are some areas in the western United States where the rooftop is used commonly for air conditioning equipment. Ductwork openings to the outdoor unit must be evaluated for noise intrusion and treated accordingly. Access for service may be a consideration in design of structures when moving units to this location.

E. Ductless Mini-Split Systems

Ductless mini-split systems are available in both straight air-conditioning and heat pump models. They are for single room conditioning, with some systems capable of conditioning up to three zones with three separate air handlers served by one condenser. Typically, the air handler/evaporator is mounted in the room itself on a wall or ceiling, while the small condenser, about the size of a medium suitcase, is mounted outside. The systems do not have ducting. The air handler/evaporator is located in or near the desired space, and air is recir-

culated within the conditioned space; therefore, outside ventilation air must be introduced by another means. These systems are used by SIPs where it is impractical to use existing ductwork or install new ductwork.

F. Adding Outdoor Air

FAA and ASHRAE guidelines require outdoor air to be mechanically provided in occupied structures if infiltration rates in the structure are insufficient to meet minimum standards for occupancy. Following the SIP treatments, structures typically will not meet minimum infiltration requirements, and outdoor ventilation will be required.

G. Energy Recovery Systems

Energy recovery ventilation systems provide a controlled way of ventilating a home while minimizing energy loss. They reduce the costs of heating ventilation air in the winter by transferring heat from the warm exhaust air to the cold outside supply air. In the summer, the inside air cools the warmer supply air to reduce ventilation cooling costs.

There are two types of energy recovery systems: HRVs and ERVs. Both types include a heat exchanger, one or more fans to push air through the machine, and some controls. The bulk of SIPs install or adapt central, whole-house ventilation systems with dedicated distribution systems or shared ductwork with the heating/cooling system.

The primary difference between an HRV and an ERV is the way the heat exchanger works. ERVs have limited-permeability heat exchangers that transfer some moisture along with heat energy, while HRVs only transfer heat. Transferring moisture from exhaust air to incoming outdoor air or vice versa allows the structure to maintain more consistent humidity levels. When used in conjunction with a central cooling system, ERVs generally offer better humidity control. Some controversy exists regarding the use of ventilation systems during humid, but not overly hot, summer weather. It may be necessary to install an enthalpy control to maintain indoor humidity.

Most energy recovery ventilation systems can recover 70% to 80% of the energy in the exiting air and deliver that energy to the incoming air. However, they are most cost-effective in climates with extreme winters or summers and where fuel costs are high. In mild climates, the cost of the additional electricity consumed by the system fans may exceed the energy savings from not having to condition the supply air.¹⁰

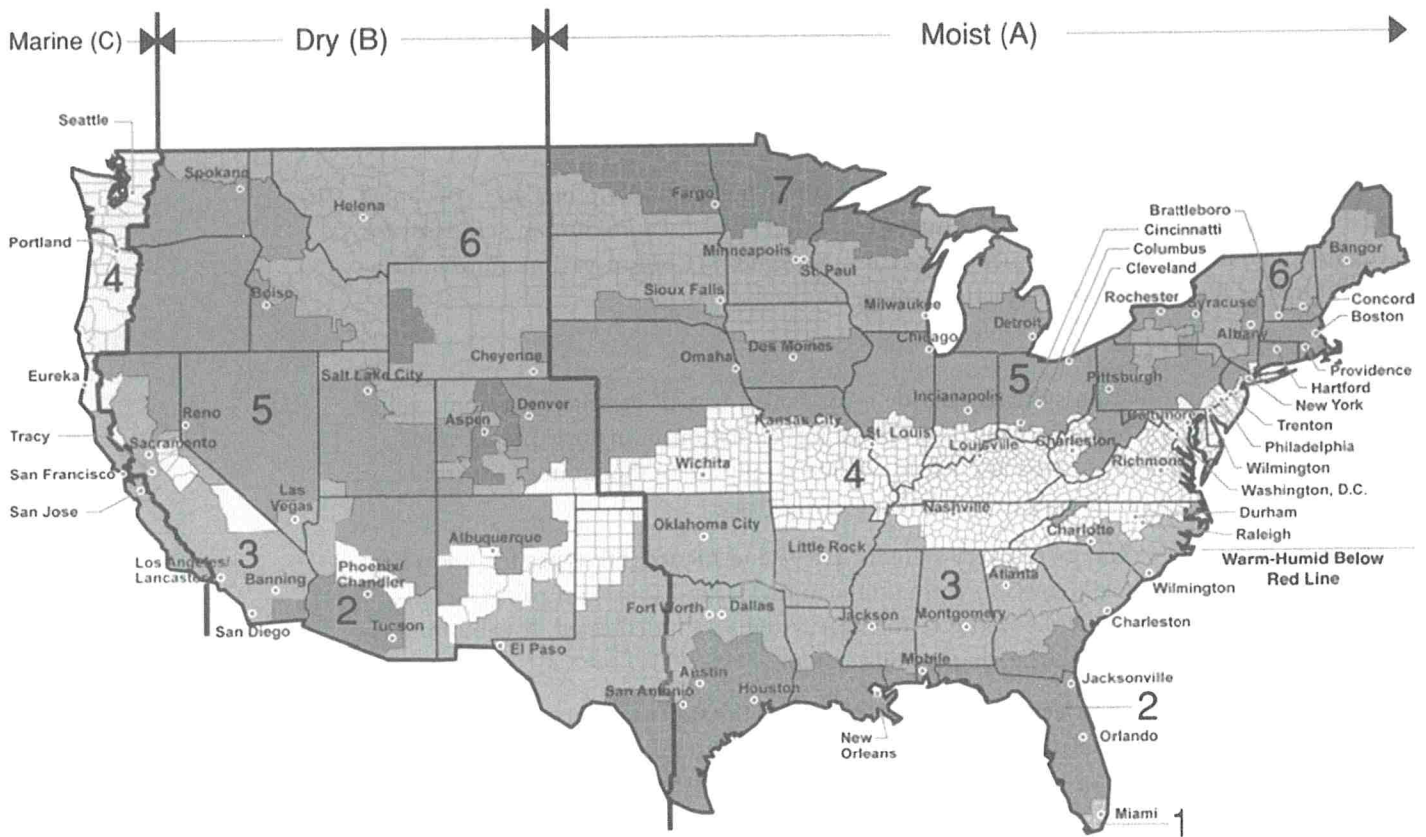
7.4.2 Regional Differences

Since sound insulation programs occur in all eight major climate zones in the United States, there is no one way to design indoor environmental systems to meet all of these conditions. Study of local engineering practice and codes will be required in each zone.

A. Energy Code Climate Zones

The 2004 IECC supplement was the first model energy code to adopt a new set of climate zones (see Figure 7.3). The older IECC zones were based only on heating degree days and did not account for cooling energy. The new climate zones were developed based on analysis of the 4,775 National Oceanic and Atmospheric Administration (NOAA) weather sites and statistical analysis of regional information.

¹⁰ Energy Efficiency & Renewable Energy, U.S. Department of Energy, accessed January 2012, www.energysavers.gov/your_home/insulation_airsealing/index.cfm/mytopic=11900.



All of Alaska in Zone 7 except for the following Boroughs in Zone 8: Bethel, Dellingham, Fairbanks, N. Star, Nome North Slope, Northwest Arctic, Southeast Fairbanks, Wade Hampton, and Yukon-Koyukuk

Zone 1 includes: Hawaii, Guam, Puerto Rico, and the Virgin Islands

©ASHRAE, www.ashrae.org. (2007) ASHRAE Standard—(90-1).

Figure 7.3. National climate zones (2004 IECC supplement).

The new climate zones are entirely set by county boundaries and are accepted and adopted by many other standards and organizations, including:

- ASHRAE 90.1,
- ASHRAE 90.2,
- ASHRAE Advanced Energy Design Guide for Small Office Buildings,
- Building America (modified), and
- Energy Star.

The important issue with energy code climate zones is that they illustrate significant differences between the eight regions within the United States that need to be taken into account when designing an SIP. The new zone jurisdictions are by county and take into account differences within each major zone. A full outline of this topic is discussed in the Building America Best Practices Series, Volume 7.1, High-Performance Home Technologies: Guide to Determining Climate Regions by County, available at http://apps1.eere.energy.gov/buildings/publications/pdfs/building_america/ba_climateguide_7_1.pdf.

B. California's Title 24

Title 24 Part 6 of the California Code of Regulations is the California Building Energy Efficiency Standards; it was legislated into law in 1978, with the current 2008 standards in effect and enforced since 2010. It is an energy guide designed to help building owners, architects,

engineers, designers, energy consultants, builders, enforcement agencies, contractors, installers, and manufacturers. The document sets standards for residential and nonresidential buildings and is written as both a reference and an instructional guide for anyone who is directly or indirectly involved in the construction of buildings. The guide is intended to supplement several other documents that are available from the California Energy Commission: the 2008 California Building Energy Efficiency Standards, reference appendices for the standards, and the *Residential Alternative Calculation Method Manual*. (The standards are not always but frequently are at a higher level than general industry.) The technical chapters cover building envelope, mechanical/HVAC, water heating (including swimming pool system requirements), and interior and exterior lighting permanently attached to the building. Mandatory measures, prescriptive requirements, and compliance options are described within each technical area, subsystem, or component. Other subjects that are covered are the compliance and enforcement process, including design and preparation of compliance documentation through field verification and diagnostic testing; computer performance approach; additions, alterations, and repairs; New Solar Home Partnership (NSHP) requirements; and Home Energy Rating System (HERS) raters.¹¹

7.4.3 Condition of Systems

Except for homes in the most temperate of climates, such as Hawaii or California's central and southern coastal areas, most residences will have existing heating or cooling systems. Before adapting an existing system to meet the requirements for SIPs, assess the condition of the system. In numerous SIPs, mechanical engineers inspect existing systems to determine the age and condition of the system and whether it has a projected service life that would at least equal the warranty period on most of the other acoustical treatments, which is 10 years. Depending on its condition, mechanical equipment older than 10 years may need to be replaced. In terms of system age, as a rule of thumb, a 20-year-old air conditioner is at the end of its useful life. A heat pump that is 15 years old can be equivalent to a 30-year-old air conditioner.

Since most residential systems do not provide outdoor air, existing systems must be evaluated for their ability to accept the added load of tempering the outdoor air to meet the ASHRAE 62.2 standard. Systems unable to accept this alteration may need to be replaced.

Cooling efficiency of residential air conditioners and heat pumps is measured using the Seasonal Energy Efficiency Ratio (SEER). Builders of homes are only required to meet the current standard at the time of construction; unless a homeowner has replaced an existing system, the system in the home was the builder's choice. SEER ratings have changed dramatically in the last 40 years. In the 1980s there was a loose standard that was changed to 10 SEER in the 1990s. The minimum standard was changed to 13 SEER in January of 2006. Energy Star-qualified central air conditioners must have a SEER of at least 14. This rating continues to increase as technology advances.

Furnace efficiencies have not changed much in the last 20 years because combustion technology is limited to the physical properties of the fuel and combustion materials. Annual fuel utilization efficiency (AFUE) is the recognized efficiency measure for combustion appliances. AFUE is a measure of the combustion efficiency of the device and does not measure electrical efficiency. Standard efficiencies for today's natural gas and LP furnaces range from 78% (the minimum standard) to 96%. Some ultra high-end units reach above this level, with significantly higher prices. Many older systems may have an AFUE in the 60% range; this would be a natural draft

¹¹ 2008 Building Energy Efficiency Standards for Residential and Nonresidential Buildings, The California Energy Commission, p. 3, <http://www.energy.ca.gov/2008publications/CEC-400-2008-001/CEC-400-2008-001-CMF.PDF>.

unit and cannot meet current standards. Standard systems today have forced-draft combustion (a small blower in the exhaust system to motivate combustion gases to exit, preventing stagnation that steals efficiency) and will be used in SIPs.

Existing furnaces and other HVAC systems will be evaluated on a case-by-case basis to determine adaptability and their remaining life span.

The issuance of PGL 12-09 has raised the question of whether the replacement of furnaces is an allowable treatment. While the FAA has not issued a definitive policy statement regarding this, it should be noted that the 1992 guidelines describe six system types that programs might need to adapt to provide ventilation air. The 1992 guidelines acknowledge that the condition and type of the existing furnace may necessitate its replacement in order to provide the required ventilation/air conditioning.¹² **Program sponsors and consultants are advised to consult with their local ADO for further clarification.**

7.4.4 ACRP Project 02-31, "Assessment of Sound Insulation Treatments"

At the time of the publication of these guidelines, the Airport Cooperative Research Program began ACRP Project 02-31, "Assessment of Sound Insulation Treatments," to conduct research and provide evaluation of the performance of acoustical products and treatments in previous SIPs, including the proper maintenance required to ensure the longevity of the installed acoustical treatments. It is recommended that users of these guidelines review the results and recommendations of ACRP Project 02-31 for further information regarding sustainable and effective noise reduction products and treatment strategies.

7.4.5 Best Practice Recommendations: Evaluating Existing Systems

1. Design of preferred ventilation and mechanical systems is heavily dependent on geographically defined environmental conditions.
2. California has special issues in regard to Title 24 that require additional considerations.
3. Issues like remaining life span, outside air adaptability, and ductwork sizes of existing systems are critical to determining the need for a new or retrofitted mechanical system for SIP-treated homes.

7.5 System Design

7.5.1 Sizing of HVAC Systems

A. Manual J: The Correct Way to Size a System

Correct HVAC system sizing requires many considerations; simply replacing an existing system with a similarly sized newer system will rarely fulfill the new requirements of a home after sound insulation improvements. In order to accurately meet the contemporary design needs of HVAC systems for SIPs, designers must use a standardized system for load calculations. The Air Conditioning Contractors of America (ACCA) produces the most widely recognized sizing

¹² See note 4. §3.5.4.2, p. 3-47.

method for residential systems and load calculations: Manual J. (The latest update is version 8.) In addition to Manual J, ACCA produces a commercial system sizing guide (Manual N), a duct sizing guide (Manual D), and an equipment selection guide (Manual T). Discussion of these additional guides follows. The most common considerations for proper system sizing are:

- Local climate;
- Size, shape, and orientation of the house;
- Insulation levels;
- Window area, location, and type;
- Air infiltration rates;
- Number and ages of occupants;
- Occupant comfort preferences;
- Types and efficiencies of lights and major home appliances; and
- Ancillary heat sources.

Manual J, version 8 (MJ-8) provides calculations and load sizing in printed and software versions for single-family detached homes, small multi-unit structures, condominiums, town-houses, and modular and manufactured homes (trailers). In addition to these standard construction types, the MJ-8 software¹³ can accommodate HVAC design in homes that have exceptional architectural features and lifestyle amenities, such as:

- Dwellings that have limited exposure or no exposure diversity,
- Homes with large south-facing glass area or rooms with unusually large glass area,
- A thermally isolated solarium,
- Customized internal load estimates, and
- Fenestration loads for glass rated by the National Fenestration Rating Council (NFRC).¹⁴

The latest version of the software can also incorporate the following geographical, physical, and operational characteristics in the calculations for final sizing:

- Improved duct load models;
- Improved methods for estimating the effects of internal and external shading devices, including insect screens;
- Infiltration estimated based on blower-door test;
- Sensitivity to latitude and altitude;
- Sensitivity to skylight glazing material, curb construction, and light shaft construction; and
- Heat gain sensitivity to roofing material, roof color, and the use of a radiant barrier.¹⁵

The software will also calculate heat loss and gain for log walls, structural foam panels, aerated autoclaved concrete block, insulated concrete panels, brick walls, concrete walls, wood foundation walls, and any other type of wall and insulation option.¹⁶

B. Additional Steps and Data

In addition to the previous lists, calculations require measurements of walls, ceilings, floor space, and windows to determine the room volumes. Confirmation of insulation *R*-values; window size, type, and location; and building materials will be necessary to complete the load calculations. A close estimate of the building's air leakage is also necessary; using results from a blower-door test is highly recommended. An inspection and description of the air distribution systems will

¹³ <https://www.acca.org/industry/system-design/software>.

¹⁴ <https://www.acca.org/store/product.php?pid=172>.

¹⁵ <https://www.acca.org/store/product.php?pid=172>.

¹⁶ See Air Conditioning Contractors of America website, acca.org.

also be necessary. These should include the placement of supply and return registers. This information will be necessary when confirming whether the existing system will support the new objectives.

Consider the architectural design of the house: are there large overhangs, extensive shading, large skylights, and so forth? Overhangs can reduce solar gain through windows. The house orientation will affect heat gain and heat loss through windows. Use the correct design temperatures and humidity for the geographical location of the building. Using an incorrect number or estimate will result in improper sizing.

After all the data are entered into the computer, the result can be printed out with all the measurements, calculations, and assumptions listed for later review.

7.5.2 Incorrect Sizing Methods

Simply replacing an existing system with another similarly designed system is not likely to yield the best results. Just checking the existing nameplate [the label on the unit that has the British thermal unit (BTU) per hour output, among other things] of a system is discouraged. The data from such a check should be used as only one factor in determining proper sizing or to determine natural gas or electrical capacity. One type of guesstimate is the rule of thumb method. This method is based on generalities that are typically geographically specific and loosely based on the size, age, and location of a home. This method has many variations, all of which are not recommended by these guidelines, nor are they in the best interest of SIP participants. Therefore, guesses and rules of thumb should not be used in SIPs. The best practice recommendation for new HVAC system design is to use computer-generated load calculations based on Manual J software or a similarly accepted and recognized alternative.

A. Why Most Older Systems Are Oversized

Before the first worldwide energy crunch in the early 1970s, homes suffered high infiltration, had poor sealing of windows and openings, and generally were leaky (as discussed in Section 7.3.4). During that era of loose construction, it was not uncommon to find furnaces and air conditioners that were (and still are) significantly oversized. In addition to owner efforts to reduce energy consumption, SIP treatments consist of energy-efficient doors and windows, which significantly reduce infiltration and building loads. Therefore, using the old nameplate data to size new equipment is likely to result in an oversized system.

B. Sizing Heating and Cooling Systems

Correctly sizing a system is critical for achieving maximum efficiency and comfort while lowering life-cycle maintenance and operating costs. Equipment oversizing is the most common issue with un-engineered systems. It causes higher system installation costs, inefficient operation, more frequent breakdowns, and higher costs. Certain limitations are built into system sizing and design for residential systems. Air conditioners and heat pumps are limited to half-ton increments up to 4 tons in capacity for most manufacturers. Anything over 4 tons for residences is limited to 5 tons. Due to the electrical construction of such units, anything over this capacity is a commercial unit with commercial power (3 phase) requirements.

Oversized air conditioners and heat pumps short cycle, meaning they run long enough to capture the sensible load, but not the latent load. Sensible heat is the heat measured by degrees on a thermometer. Latent heat is the heat within the moisture or humidity suspended in the air. The total amount of humidity in air varies by temperature; the warmer the air, the more moisture it can hold. Generally stated, a space with 50% to 60% humidity is considered comfortable. One of the benefits of an air conditioning system is that it also removes humidity from air as it cools.

The big issue with oversized systems is that the air temperature changes quickly without much humidity condensing on the evaporator coil before the system cycles off. The result is a space where the temperature drops but the humidity rises above the comfort level. The space then feels cool, but moist or clammy like the inside of a cave. The analogy is further supported in extreme conditions because surfaces within a home condense moisture as the inside dew point rises with high relative humidity. This is undesirable not only for the comfort of the occupants but also for their health. A high humidity condition over a prolonged period will cause unhealthy mold and bacterial growth within the duct system, air handler, or home materials.

Oversized heating equipment is also a problem for similar reasons. Capacities for furnaces tend to run in increments of 20,000 BTUs, starting at 40,000. In addition to combustion limitations, there are airflow limitations with each size. The smaller capacities tend to have air blowers capable of supporting air conditioners of 1 to 2 tons. Each size thereafter is capable of supporting a few different sizes of air conditioners. Manufacturers make units generically to cover the entire country; this leads to standardization of heating capacities that will span the gamut of conditions. A system for a seacoast home in Maine will need more heat and less air conditioning than a farmhouse in Georgia. Since most manufacturers would rather err on the high side regarding heat capacity, it is more common for a system to have more heat than it needs rather than too much airflow. Therefore, when a system that has high air-conditioning demand and low heat demand is needed, the higher capacity units will be used to achieve the airflow necessary to drive the air conditioner, and the heat will cycle more than is desirable. Caution needs to be exercised to not oversize since it can cause uncomfortably large heating temperature swings within a building. It is best to size equipment as closely as possible to the load calculations for the most efficient operation. For a brief discussion of proper sizing of air distribution ductwork in addition to equipment sizing, refer to Section 7.5.4.

C. Last Note on Sizing

It may be prudent in certain projects to exceed design standards both within the envelope and when choosing the equipment serving the building. This is apparent when considering the impact of west-facing glass and multi-pane, heat-absorbing glass, as well as when designing for localities with extreme ambient conditions. In all cases, it is advised that the SIP team consider several factors before finalizing system design: up-front costs, long-term effects for minimizing envelope permeability, maximizing the aesthetic, and gaining maximum efficiency.

7.5.3 Standard Systems

A. Outdoor Air Ventilation Only

This option can be considered for regions where the climate is temperate throughout most of the year, where mechanical cooling is not required on a regular basis, and in buildings that have existing functional heating systems. For example, coastal regions that do not experience significant humidity can be a good fit for the consideration of ventilation. Adding ERVs can enhance the overall effectiveness of a ventilation-only system.

Ventilation systems typically make use of a fan (ventilator) that draws outside air into the building through ductwork and pressurizes the interior of the building. Positive building pressure causes air to be pushed out of the building through sound-attenuated exterior openings (louvers) at the same rate that outdoor air is being brought in. Alternatively, the ventilator can exhaust air from the building, and by doing so, induce outdoor air to enter the building through weatherproof and sound-attenuated openings. Filtration of the outside air is required. Removable filters are typically located within the ventilator package for positive pressure systems; exhaust systems would require filters to be installed at all outside air openings.

B. Full Central Heat and Air (Split Systems)

For regions that experience relatively warm summers, high humidity levels, colder winters, or any combination of these, a complete central HVAC system should be considered. The system is made up of a central forced-air unit (FAU) paired with an outdoor air conditioner that distributes heated or refrigerated air to occupied spaces through a network of ducts. This approach is particularly appropriate for buildings or homes that have old, inefficient, or ineffective heating systems. The heating source could be either natural gas or electricity. Split-type direct expansion (DX) refrigerant-based air conditioning would provide cooling.

Full central air conditioning systems make use of an indoor furnace or FAU, which typically serves to push air throughout the supply ductwork system as well as to provide heating via a gas burner and heat exchanger. The indoor furnace or FAU is paired with an outdoor condensing unit. The condensing unit produces the mechanical cooling and is connected to the indoor FAU via a pair of refrigeration pipes—one for supplying liquid refrigerant to the FAU and the other for returning vapor refrigerant to the condenser.

C. All-Electric/Heat Pump Systems

Similar to full central heating/air conditioning systems, central heat pump systems are suitable for regions that experience hot or cold weather and for buildings that lack efficient or effective heating systems. Central heat pump systems are all-electric. Both cooling and heating are provided by mechanical means, namely DX refrigerant being pumped by a compressor.

Full central heat pump systems make use of an indoor FAU or fan coil, which typically serves to push either hot or cold air throughout the supply ductwork system. The indoor FAU is paired with an outdoor condensing unit or split heat pump. The condensing unit produces both mechanical cooling and heating and is connected to the indoor FAU via a pair refrigeration pipes, one carrying liquid refrigerant and the other carrying vapor refrigerant.

D. Ductless Mini-Split in Conjunction with Outdoor Air

Ductless mini-split systems (sometimes referred to as ductless wall-mounted systems) provide spot cooling or heating in rooms that do not have adequate space (either above the ceiling or below the floor) to install ductwork for proper air distribution. Instead, ductless mini-split systems tend to be installed within the conditioned space, either on a wall or hung from the ceiling, and circulate air within the room while simultaneously cooling or heating the air. They are capable of providing cooling or both cooling and heating in heat pump configuration. Ductless mini-splits need to be paired with an outdoor component, typically referred to as an outdoor condensing unit. Since ductless mini-splits are typically not capable of introducing outdoor air into the occupied spaces, they should be installed in conjunction with an outdoor air system. See Section 7.7.2 for further discussion.

E. Add Outdoor Air to Existing Central Heat and Air System

Some buildings have an existing, functioning central cooling and heating system already installed, but no provision for outside air or ventilation. In such instances, outdoor air can be ducted into the central air conditioning system to provide ASHRAE-required minimum outside air rates.

F. Roof-Mounted Package Systems

Packaged air conditioning systems (whether gas/electric or heat pump) have all the heating, cooling, and fan equipment in a single box or package. They can be installed with gas heating or in heat pump configuration (mechanical cooling and heating). They can be considered for buildings with adequate roof space available for mounting the packaged air conditioning unit. Buildings on which they are installed should typically have adequate ceiling or

attic space available for installing air distribution ductwork. In instances where no attic space is available, ductwork can be installed on the roof; however, care should be given to properly seal all points where ducts penetrate into the interior space. A factor that can influence the practicality of roof-mounted packaged air conditioning systems is whether the region in consideration has high levels of seismic activity. In such regions, local building codes typically require structural and seismic calculations for most roof-mounted equipment, which can be an added cost factor. In addition, local ordinances may limit the installation of roof-mounted equipment for aesthetic purposes.

Energy Recovery Ventilators. Regardless of the system type chosen for a particular SIP, some additional energy recovery may be needed to present an acceptable package to decision makers. ERV units have risen in popularity in localities with extreme ambient conditions and provide a means to recover energy before it is rejected from the building. ERVs are generally suitable for commercial applications with high occupancy rates, but they are making an appearance in new residential construction. Most manufacturers of fan systems now offer some level of ERV for residential use. Energy recovery occurs as conditioned air is rejected to the outdoors through one side of a heat exchanger; ventilation air passes through the opposite side of the same heat exchanger, thus exchanging energy between the two sections into the passing air. The now-tempered air enters the mechanical system or moves directly to the living space. Refer to Section 7.7.2 for information regarding common types of heat exchangers. Consideration of an ERV must include the energy used to push or pull air through the outdoor air heat exchanger as well as the thermal savings from transfer. Just as infiltration increases with large disparities in temperature and humidity, greater energy recovery occurs in an ERV when there are large differences in temperature or humidity. Therefore, higher differentials across an ERV equate to higher efficiency and cost-effectiveness. ERVs are a viable option for ventilation in areas where dwellings experience a high average differential between indoor and outdoor temperature.

Controls. Each HVAC system or zone requires thermostatic control to maintain room temperature. It is preferable, and occasionally required by IECC and local codes, to install programmable controls. Programmable controls offer the opportunity to adjust set points for optimum temperatures during disparate occupied modes. Programmable thermostats often compare closely to standard thermostats in cost and can be packaged with new equipment. It is a good idea to include them in the design checklist to avoid any oversight.

7.5.4 Ductwork

Achieving occupant satisfaction is the principal goal of any HVAC design and an important goal of SIPs. In a perfect world, duct systems would deliver fully conditioned air to the desired space, in the desired volume, at the desired rate, and only for the duration necessary for space conditioning and occupancy comfort. Unfortunately, this is not the case, especially in existing systems.

A. Existing Systems

Depending on geographic location, age of the home, and local standards, it is possible for existing systems to be made up of almost anything as far as ductwork is concerned. The system could be made of galvanized steel, steel, aluminum, or even stainless steel, and of any gauge from 30 to 20, depending on the dimension and tonnage of the system. The system could be made of spun fiberglass sheets with a paper/foil barrier (duct board) cut and fitted together. There are numerous thicknesses and varieties of duct board. It is also possible to have wooden ducts due to joist panning where a joist has sheet metal nailed to the bottom of two adjacent joists to

form an air path. Return air systems can be all of the previously mentioned materials or flexible duct. There could be no return ducting, open plenums, and louvered doors. Branch ducts are often flexible class-one insulated duct, metal, duct board, or some combination. In conditioned space, uninsulated class-one duct or connector duct can also be used. That being said, it is readily evident that examination, measurement, and careful consideration should be exercised before simply putting new equipment on an existing distribution system.

B. Air Leakage

To say that existing duct systems in homes leak is an understatement. Unless a particular home has a custom-installed system by a conscientious contractor, it is unlikely that the joints, takeoffs, and outlets were sealed by mastic, which is the current standard. These unsealed mechanical joints, tap ins, or connections can lose considerable air or draw in the air surrounding ducting. As discussed in Section 7.3.4, pressure differences cause air movement. Similar to other forms of pressurization and infiltration, the forced air of a mechanical system can cause unwanted issues. All leaks rob mechanical systems of energy, but inward leaks pull in pollutants and contaminate the inside of ductwork.

C. Heat Conduction

System efficiency is critical for homeowners, yet few existing systems are sufficiently insulated. Conduction of heat occurs when the temperature difference between the interior and exterior of the duct is sufficiently high. Metal ducts with no insulation conduct the most heat, those with little insulation a little less, and so on. Some existing systems that are heat only do not have vapor barriers on the insulation. Systems without vapor barriers on the insulation cannot be used for cooling. Some duct-board systems use board that is too thin and subsequently have low R -values, which can cause problems beyond conduction, especially in high vapor pressure areas like crawl spaces. During cooling operation, the cold interior of the duct can cause condensation on the surface of the ducts and saturate the material. This can lead to microbial growth and eventually destruction of the duct. Low R -value insulation on metal ducts can also cause condensation and moisture problems.

One significant issue with existing systems is flex duct. There are many types of flex duct. Some of the earliest manufacturers used rubber-based products in the liner, which deteriorate over time. Other manufacturers used glues to bind layers of material together in the liner, which separate with age. Still others used polyvinylchloride- (PVC-) based exteriors, which dehydrate and split with heat and age. Another issue with flex duct is improper sizing. The earlier products had low R -value insulation; products are now required to be R -6 or R -8. The interior and exterior materials are also significantly better, with fused Mylar liners and a Mylar/fiberglass mesh reinforced/foil exterior. Conduction becomes an issue when flex duct comes into contact with disparately tempered surfaces. The most significant problem occurs when sagging flex duct contacts the ground, which causes moisture problems, including puddles of condensation within the duct. The many issues with conduction reveal the need for thorough examination of existing duct systems.

D. New Systems

New system installations must meet specific standards; SMACNA, ANSI, and ACCA are the most recognized organizations with standards for duct construction. ANSI recognizes both the SMACNA and ACCA standards. The current standards are SMACNA's HVAC Duct Construction Standards – Metal and Flexible and ACCA Manual D Residential Duct Systems. The SMACNA standard covers all duct systems while ACCA is specific to residences. Few existing systems will meet the current standards for airflow, proper sizing, proper sealing, and the many other components of the standards.

The third edition of ANSI/ACCA Manual D uses Manual J (ANSI/ACCA, Eighth Edition) for heating and cooling loads and to determine space air delivery requirements for low-rise, residential-use buildings. By matching sizing requirements to duct system resistances (pressure drop) and blower performance (as defined by manufacturer's blower performance tables), the entire system will perform the most efficiently. This ensures that appropriate airflow is delivered to all rooms and spaces and that system airflow is compatible with the operating range of primary equipment. Advantages of designing with Manual J are:

- Updated and expanded variable air volume (VAV) guidance, with detailed examples;
- Impacts of excess length, sag, and compression in flexible ducts;
- New equivalent length values for flex duct junction boxes;
- A single set of ANSI-recognized duct sizing principles and calculations that apply to all duct materials;
- System operating point (supply cfm and external static pressure) and airway sizing for single-speed and multispeed blowers;
- A method for determining the impact of duct friction and fitting pressure drop on blower performance and air delivery; and
- The most comprehensive equivalent length data ever published.

Although it is unlikely that all of the options of Manual D will be used in SIPs, Manual D is the proper standard to apply to systems requiring ducting. Designers can apply the Manual D procedure to constant volume systems and zoned variable air volume systems using a full range of duct construction materials. Manual D includes a number of informative appendices related to air distribution systems (e.g., equipment and air-side components; controlling excess air when VAV dampers close; duct loads, duct leakage, and duct system efficiency; air quality issues; noise control; minimum air velocity for ducts; codes, standards, and best practice issues; and commissioning issues). As mentioned previously, HVAC systems outside the building envelope require careful sealing of joints and ducting. This includes attics, garages, and crawl spaces. It follows that, wherever possible, HVAC systems should be installed within the envelope.

7.5.5 System Operation Costs

The *AIP Handbook* identifies the issues of ongoing operation and maintenance of mechanical systems as a cost issue for property owners. The FAA advises that SIPs provide an operation and maintenance cost projection for the new system as part of the process of design and presentation of the scope of work to the homeowners. Once the systems have been installed as part of the sound insulation project, the upkeep becomes the responsibility of the owner. The *AIP Handbook* states:

Two caveats should be discussed with sponsors and recipients who receive air conditioning or a continuous positive ventilation system:

(a) The recipient will be expected to operate the system installed under the AIP grant to preserve the noise attenuation benefits achieved with the insulation project. Failure to use the installed system will negate the benefits and will not be grounds for making complaints about noise levels.

(b) Property owners and residents should be presented with information about utility and maintenance costs for the installed equipment. Increased utility costs are to be expected. Also, routine maintenance costs should be planned to keep the system operating at peak efficiency. Maintenance service contracts tend to minimize disruptions by providing regular checks of the installed system. The costs of these contracts are a responsibility of the property owner.¹⁷

¹⁷ U.S. DOT, FAA, FAA Order 5100.38C, *Airport Improvement Program Handbook*, June 28, 2005.

7.5.6 Best Practice Recommendations: System Design

1. Use computer-generated load calculations based on Manual J software or a similarly accepted and recognized surrogate.
2. Be aware of practices and assumptions that lead to incorrect sizing methods, oversized units, and poor air quality for occupants.
3. Consider several factors before finalizing system design: up-front costs, long-term effects for minimizing envelope permeability, maximizing the aesthetic, and gaining maximum efficiency.
4. Examination, measurement, and careful consideration of ductwork should be exercised before installing new equipment on an existing distribution system.
5. Install HVAC systems within the envelope, whenever possible.
6. For design purposes, the minimum energy standard for all SIP-associated equipment is Energy Star.
7. Programs are advised to present property owners and residents with information about utility and maintenance costs for the installed equipment.

7.6 Developing Program Policies

There is no one-size-fits-all approach to designing mechanical systems. It is important when establishing policies for SIP HVAC systems to answer these questions:

- What are the standard types of mechanical systems in the buildings to be treated?
- What level of energy efficiency will the program provide? Minimum code? (These guidelines recommend Energy Star practices and products for SIPs.)
- What condition does the existing system have to be in to be replaced?
- What protocols will be decided for ductwork?
- How will outdoor air be provided to meet ASHRAE standards?

There are many factors to consider when creating policies for retrofitting buildings to receive updated HVAC systems. Many programs find pilot programs useful to ascertain existing conditions and to design policies after the initial assessment of existing conditions.

7.6.1 Impact of PGL 12-09

PGL 12-09 advises that continuous ventilation systems can be provided where interior noise levels are less than 45-dB DNL and where there is no existing ventilation system and ventilation depends on having windows open. It states that “a Continuous Positive Ventilation System is the allowable package for these residences. . . . The sponsor may recommend an air conditioning system in lieu of ventilation only.”¹⁸

Questions have been raised by program sponsors and consultants regarding whether a continuous ventilation system is considered a secondary treatment and whether this type of treatment is limited to a specific number or percentage of homes. **Program sponsors and consultants are advised to consult with their local ADO for further clarification.**

¹⁸ See note 2. Attachment 1, §812 (d), p. 1-13.

7.6.2 Establishment of Policies

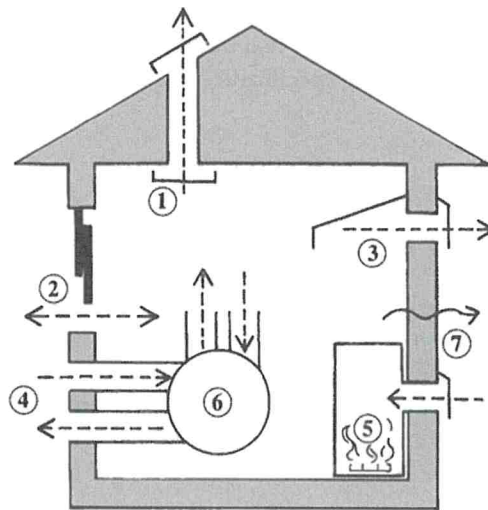
A. Air Quality

Programs need to examine several air quality and environmental issues when establishing policies. Issues include managing existing hazardous materials such as lead and asbestos, evaluating new material hazards and VOCs, providing appropriate levels of ventilation, controlling moisture and humidity, and checking the installation and operation of HVAC systems and fuel-burning appliances (see Figure 7.4). Potentially, a number of homes will have existing air quality problems, the correction of which is typically outside the scope of most SIPs. A minimum practical objective would be to not make things worse. In many cases, a modest expenditure on treatments can ensure a minimum level of performance and reduce the risk of problems.

B. Combustion Air

SIPs may also include fuel-burning appliance testing, testing by the sponsor under the program policy, or simple system maintenance in the construction package. Other recommendations include:

- Understand ASHRAE 62.2, Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings, and create design solutions that meet this standard.
- Review how new air handling systems relate to air quality. Look at leakage of ductwork in unconditioned spaces, the effect of climate on system design, and changes in air pressure differentials that move moist air through walls.
- Add operable, low-noise bathroom exhaust fans, and make sure existing ones vent to the outside. Maintain kitchen exhaust fan operation. (They should not be made into recirculating types.) Dryers must be vented directly to the outside.
- Make sure each homeowner knows the purpose of the exhaust system and the importance of its use.



Houses can have many ways of providing ventilation:

- | | |
|--------------------------|-------------------------------|
| 1) bathroom fan | 5) duct to return-air plenum |
| 2) open window | 6) central ventilation system |
| 3) kitchen fan | 7) holes in the envelope |
| 4) exhaust or supply fan | |

Courtesy of the Office of Energy Efficiency (OEE) Natural Resources Canada (NRCAN).

Figure 7.4. Home ventilation pathways.

C. Moisture Control

Abating existing excess moisture/leaks in buildings is generally outside the scope of SIPs. With the exception of ventilating for habitation and air quality, there are methods for preventing non-behavioral sources of moisture:

- Ensure that window installation conforms to requirements to preclude water leakage.
- Examine conditions that require penetration of the roof or exterior walls that may leak.
- Look for pre-existing conditions that may affect the participation of a home in the program, such as the presence of mold, crawl spaces without moisture barriers, and poor drainage. These conditions may require remediation by the homeowner prior to sound treatments.
- Provide information to owners regarding control of interior humidity, the types of activities that cause excess humidity, and steps to reduce humidity.
- Provide adequate intake and exhaust ventilation in attics.

The approach for evaluation of fuel-burning appliances may vary significantly by climatic region, program policy, and type of housing stock. Issues to consider/tasks to perform include:

- Replacement heating systems that incorporate new combustion technology, including sealed-combustion systems (systems that intake outside air directly to the combustion intake, not the space).
- Check local code compliance of existing systems for combustion air venting and adequacy. Include draft inducer fans where necessary to overcome negative pressurization or flue inadequacies, or add required venting. Venting for combustion air may come from adjacent rooms, unconditioned space, or outdoor air.
- Evaluate existing appliances for possible reduction of carbon monoxide emissions. Adjustments can be included in the general contract, or the systems can be tested during the design phase.

7.6.3 Specifying Manufacturers

Many programs provide HVAC systems with warranties that extend beyond what is standard. Not all HVAC equipment is of a quality to provide the desired length of warranty. In addition, programs endeavor to provide equipment that building owners will recognize as a quality product. Setting the standards for bidding specifications to fulfill these expectations is an important early step in design.

7.6.4 Best Practice Recommendations: Program Policies

1. Recognize that air quality changes from home to home and space to space. There is no one-size-fits-all or rule-of-thumb approach to designing mechanical systems.
2. Document pre-existing conditions of moisture control problems that may need to be remediated by the homeowner prior to conducting any work in the house.
3. Specify high-efficiency and industry-recognized, quality equipment whenever possible.

7.7 Emerging Energy Design

7.7.1 ASHRAE 90.2, Energy-Efficient Design

ASHRAE 90.2-2007, Energy-Efficient Design of Low-Rise Residential Buildings, has raised the minimum efficiencies and minimum requirements for new residential construction to qualify as an energy-efficient design for new construction of residential buildings. The basic criteria within

the standard are aimed at reducing total building energy. The method for achieving the standard involves higher efficiency equipment, appliances, and materials for all buildings, including existing dwelling units and new additions. The goal of the standard is to have a greater scope than merely the installation of higher efficiency equipment. Meeting the annual energy cost compliance requirements for the entire residential dwelling involves proper thermal insulation for walls, roofs, and windows. Design teams should review the requirements for the individual components of a structure to ensure total envelope compliance where local codes include these standards. Design teams need also be mindful that treatments eligible for reimbursement from the FAA are those that contribute to meeting FAA acoustical goals; however, meeting those goals with Energy Star practices and products can maximize the achievement of federal goals for energy efficiency.

7.7.2 Options for Energy-Efficient Ventilation

A. Making a Choice

As federal regulations and local energy code requirements dictate higher overall energy efficiency, it is necessary for the design team to review and consider various methods for compliance with both the codes and ASHRAE standards. Particular care is needed where the IECC is an adopted component of the local building codes because they have directives that may override certain design criteria. In many western states, more stringent energy code requirements necessitate design team analysis for the most cost-effective solution. The solution needs to comply with requirements for ventilation yet be cognizant of the operational cost shouldered by the building owner. Clearly, the designed solution must consider the impact of ventilation strategies and the associated operational costs. It is possible to overcome the advantages of higher efficiency equipment with ventilation strategies that require constant introduction of outdoor air. As an example, exhaust fans that operate continuously offer a host of issues for end users, including energy cost concerns, life-cycle costs, uncontrolled infiltration due to negative pressurization, and increased dust and dirt within grills and ducting.

Many of the following equipment types are available in package configurations, essentially a plug-and-play type of finished product. These products can be installed in series with other mechanical systems or stand alone, depending on design criteria. One area of concern for these and many other systems is the architectural consideration of fitting another piece of mechanical equipment into dwellings that typically have limited space for mechanical systems.

B. Outdoor Air Economizers

As SIPs tighten homes to prevent the intrusion of noise, mechanical systems become a necessity rather than an extravagant program extra. Additionally, as demand for conformity to efficiency standards becomes more stringent, houses become less permeable, and forced ventilation becomes more commonplace. Although this seems counterintuitive, to bring in outdoor air after sealing infiltration points, standards for indoor air quality must be maintained. The benefit of mechanical ventilation is the ability to measure and control outdoor air to a minimum standard. The addition of outside air, even under control, may drive overall system efficiency downward; therefore, the treatment of outside air will become necessary. Treatment of outside air can be achieved through many means, including outside air economizers (OAEs), various types of heat exchangers, permeable membranes, desiccant wheels, and heat tubes. In commercial or institutional buildings, OAEs are prevalent; in homes, however, outdoor air issues and their various solutions are emerging. The recommended purpose of ancillary ventilation equipment is, therefore, to transfer heat, humidity, and other building energy to incoming air, thereby reducing operational costs. Each treatment type has inherent costs and benefits; their cost impacts will need to be evaluated on a case-by-case basis in order to determine their suitability. Geographical location and local codes will affect which choice is optimum for each site.

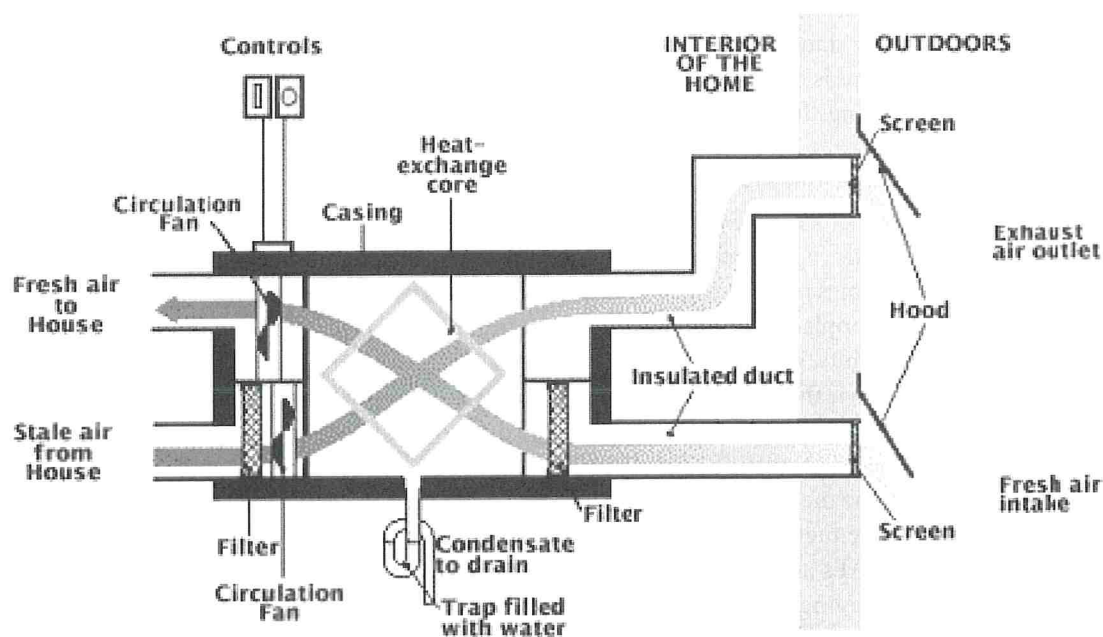
C. Dedicated Outside Air Systems – Demand-Controlled Ventilation

Dedicated outside air systems (DOAS) or demand-controlled ventilation (DCV) systems are typically used in commercial or institutional buildings where the outdoor air requirements can consume upward of 50% of a building's energy requirement. As outside air requirements moved into the residential market, residential-scale versions of these systems were developed. These systems are designed to control specific volumes of outdoor air. Some standards allow the option to choose the specific amount of ventilation air required for a residence based on the occupant load of a residence as opposed to the building load. That choice will be driven by the expected increase in operational costs if the minimum ventilation for the structure significantly exceeds the minimum ventilation for the maximum normal occupancy. Such a case could occur in a home with high or vaulted ceilings, which would significantly increase the total cubic feet of air within the structure. Reduced ventilation is also allowable during unoccupied hours. However, when mechanical ventilation is code-mandated, it is generally required to be continuous. Controls are available to determine the occupancy status and toggle the requirement for ventilation if intermittent operation is permitted. Specifically, CO₂ sensors have proven to be effective measurement devices for triggering specific modes of ventilation. This method of operation may allow for a reduction in unneeded outside air and a subsequent reduction in operational costs.

D. Installation of HRV or ERV Systems

Both HRV and ERV units are used to remove stale indoor air from homes and replace it with outdoor air. The basic difference between the two is the exchange of moisture; ERV is full energy recovery (heat and moisture), whereas an HRV only exchanges heat. The installation of these two units is practically identical and will be discussed as one type of unit, an ERV, unless specified. The basic installation types are *stand alone* and *integrated*.

Figure 7.5 is a representational image of a typical HRV; the important difference between an HRV and an ERV is in the materials in the heat exchanger core. The materials of an ERV allow the permeation of moisture through to the space's supply air, and an HRV only exchanges temperature. The exchange of moisture can help with humidity control, especially in situations where extreme differences in interior and exterior moisture levels occur. In humid, cooling-



Courtesy of the Office of Energy Efficiency (OEE) Natural Resources Canada (NRCAN).

Figure 7.5. Components of an HRV.

dominated climates, it is important to dry out incoming ventilation air to prevent mildew or mold from occurring in the ductwork. However, keep in mind that ERVs are not dehumidifiers; their moisture control capabilities are limited. In cold, heating-dominated climates, the increased ventilation air and the re-introduction of humidity to the indoor environment can help control wintertime window condensation and static electricity.

E. Stand-Alone Units

Stand-alone units are installed without any duct connections tied into the existing or new air-conditioning or heating system. There will be no common air return or delivery system; the ventilation provided by the ERV will enter and exit the home through dedicated grills, ducts, and openings. Depending on the name brand of the system designed/purchased, there may be factory-provided installation kits with pre-insulated ducts, mated inlet and outlet grills, and sound attenuators to keep air movement and fan noise down. Other units will need field-fabricated/-assembled ducting. All duct systems need to meet the codes of the highest local standard or jurisdiction. Figure 7.6 illustrates the exchange of air in a residential structure.

Where the unit is installed has a significant impact on where the inlet and outlet ducts are installed. Additionally, the actual inlet and outlet will need to be located in an appropriate wall, ceiling, soffit, or roof penetration that works with the unit's location. An HRV system can incorporate small, separately switched booster fans in high moisture or odor-producing rooms to help control moisture or heat generated by activities like showering or cooking. Range hoods will generally be separately ducted. An additional design consideration is whether to install tees in the supply ducting to individually ventilate rooms or choose a central location and allow natural air movement and changes in air density to circulate the outdoor air. Efforts should be made to use short runs of flexible duct to prevent excess restriction of airflow; in long runs, standard stovepipe-style ducting should be used. Units for residential service come in both 120- and 240-volt systems and include standard controls, and some have variable speed fans.

F. Integrated Units

Integrated units are used in conjunction with existing ducting and systems. Their key benefit is lower cost. It is simply less expensive to integrate with an existing system than it is to install a secondary stand-alone system. Space inlet and outlet air to the ERV can be picked up from the existing air stream, leaving only the outdoor portion to be completely new.

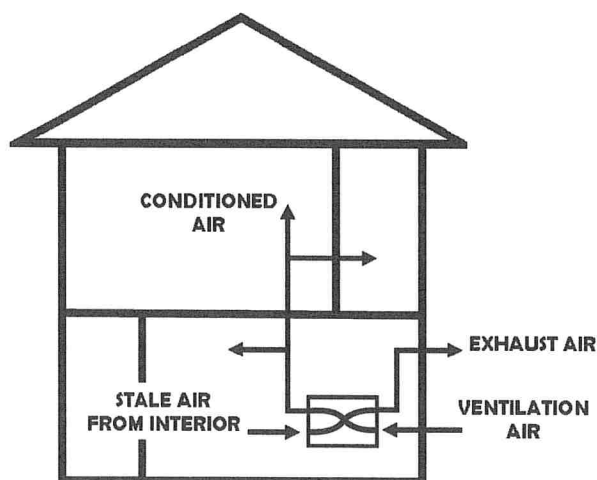


Figure 7.6. Residential air exchange.

Duct runs should be as short and straight as possible. The correct size duct is necessary to minimize pressure drops in the system and improve performance. Insulate ducts located in unconditioned spaces, and seal all joints with duct mastic. (Never use ordinary duct tape on ducts.)

According to the EPA energy website, most energy recovery ventilation systems can recover about 70% to 80% of the energy in the exiting air and deliver that energy to the incoming air. However, they are most cost-effective in climates with extreme winters or summers and where fuel costs are high. In mild climates, the cost of the additional electricity consumed by the system fans may exceed the energy savings from not having to condition the supply air.

Energy recovery ventilation systems require more maintenance than other ventilation systems. They need to be cleaned regularly to prevent deterioration of ventilation rates and heat recovery and to prevent mold and bacteria on heat exchanger surfaces.

7.7.3 Best Practice Recommendations: Energy Design

1. Consider ERVs or HRVs when designing ventilation to meet new air quality standards, as opposed to using continuous-operation bath and kitchen fans.
2. Providing adjustable modes of operation can reduce total energy consumption.
3. Install ducting for ventilation according to jurisdictional standards or manufacturer's instructions.

7.8 Additional Design Considerations

7.8.1 Code Deficiencies

A. Mechanical

Typical mechanical code deficiencies involve the following:

- Inadequate spacing between outdoor air intakes and combustion vents;
- Lack of outdoor air (ventilation) in a building, or inadequate ventilation;
- Inadequate anchorage of roof-mounted equipment to the roof structure;
- Inadequate seismic bracing for ceiling- or structure-suspended equipment, such as fan coils, furnaces, and ductwork; or
- Inadequate strapping of domestic water heaters in seismically active regions.

B. Electrical

Typical electrical code deficiencies involve the following:

- Lack of ground fault interrupter on receptacles near kitchen or bathroom counters;
- Lack of adequate clearances around and in front of electrical panels, meter/load centers, sub-panels, and disconnect switches;
- Improper electric utility service entrance into the property, weather heads and related conduits, or feeder sizing;
- Undersized electric utility service, resulting from the addition of new air conditioning in properties that previously had none;
- Lack of attic lighting in instances where mechanical (HVAC) equipment is installed in the attic; improper location of attic light switch (switch not within proper proximity of the attic access panel); or
- Antiquated knob-and-tube electric wiring.

7.8.2 Electrical Upgrades

The addition of HVAC to certain buildings may trigger an upgrade to the existing electrical system installed in the building. Electric meters or combination meter/load centers may need to be replaced with new ones. Code-deficient or undersized utility service entrance cable, including the weather heads, may need to be replaced as well if the electric service is being upgraded. The utility company typically covers the cost of running new conductors from its transformer up to the service entrance or weather head.

7.8.3 Electrical Utility Coordination

A service upgrade may be required if the required electrical amperage for the new HVAC system being recommended causes the building's electrical demand to exceed the code-regulated or utility-mandated maximum allowable capacity of the existing service size.

Service upgrades must be coordinated with the local utility and building department. Often a cluster of electric service upgrades for multiple buildings concentrated within a specific neighborhood triggers a necessary upgrade of the transformers installed within the neighborhood. Although the SIP design team is typically not responsible for utility-owned transformer upgrades, it is important that the design team share with the local utility company the anticipated electric load increases that will result from the addition of air conditioning systems. This will allow the local electric utility to plan for any potential impact to their electric distribution network. This scenario is most relevant in neighborhoods or districts that historically have not had air conditioning systems installed and that thus may experience a significant increase in electricity demand after their installation.

7.8.4 Coordination with Other Parties

A. Management of the Architecture and Engineering Interactions

As with most construction projects, many disciplines or trades are involved. The architectural design and HVAC design professionals need to coordinate treatment designs to the property. It is important that the design be integrated and communicated to the building owner.

B. Accommodating Interior Components of HVAC Systems

The addition of HVAC systems occasionally requires changes to the structure of the building being treated. Depending on the attic, crawl, and unconditioned spaces available in a dwelling, there may need to be soffits, chases, drop ceilings, closets, or other structural changes to contain system changes. Soffits and chases are virtually the same sort of construction except that soffits run along horizontal surfaces and chases are mostly vertical structures. As long as the systems are sealed and do not require access for maintenance, these structures are acceptable. If access is required, closets with doors or access panels need to be installed.

Replacement equipment located in the interior of the house, such as air handlers, may not be the same size as the old equipment. It is important to verify the maximum and minimum clearances needed for new equipment and determine if alterations to closets or other architectural constructions will be necessary. Reducing interior storage space often requires negotiation with the building owner, and locations cannot be assumed until discussed.

C. Homeowner Associations, Covenants, Conditions, and Restrictions

Many neighborhoods have restrictions to construction and home features. Before construction begins in any homeowner association (HOA), deeds covenant restricted, architectural restriction community, historical district, or other form of neighbor agreement community,

the restrictions of that neighborhood must be determined. Consultation can be in the form of compliance with the written agreements of the association or through cooperation with the compliance body. Working with the association personnel will ensure compliance.

The location of new units outside the envelope of the structures may be restricted to a specific type, color, or size. Screens or other constructions may be necessary to meet zoning codes or deed restrictions. It is imperative to determine what restrictions may exist.

D. Products, Warranties, and Service Contracts

In systems where new equipment is required, the desired warranty on selected equipment needs to be determined as a program policy. Some manufacturers of equipment do not give the desired warranty length with the equipment. Many manufacturers now offer extended warranties on specific parts or all of the unit parts but not on the labor. Generally, labor is only included during the first year or the first 5 years, depending on the manufacturer. However, as unit efficiency and features increase, the manufacturers offer longer and more robust warranties. Unit efficiency increase also means a unit cost increase. The design requirements will dictate the equipment choice.

The best practice recommendation for the minimum energy standard sought for all SIPs is Energy Star.

From the EPA Energy Star website, minimum standards entail air conditioners and heat pumps with SEER ratings of 15, oil furnaces with AFUE of 85% or higher, and gas furnaces of 90% AFUE or higher. It is likely that units this far above the builder's standard will come with extended warranties.

In cases where the factory warranty of a unit is not sufficient to meet the parts and labor standard sought, a purchased warranty may be necessary. All major manufacturers offer extended warranties for a price. These warranties are a complement to the proffered warranty, but sometimes they have a requirement for service to remain in compliance with warranty issues. The required service is typically a service contract. Service contracts ensure compliance with the required regular maintenance (i.e., cleaning, filters, and operational checks) to guarantee proper operation and avoid breakdowns resulting from poor or absent maintenance. It is rare for programs to provide these service contracts.

Specifically, the ERV and HRV equipment warranties may be limited; at the time of this writing, extended warranties may not be available to fulfill the needs of the sound insulation design team. Due to the emergent nature of these products, the abundance of manufacturers, and the variation in features, market research will be required to find a group of manufacturers suitable for SIPs willing to compete with equivalent quality products. It may be required to negotiate warranties directly with manufacturers or request design considerations to meet requirements suitable for long-term warranties.

7.8.5 Easements and HVAC Unit Placement

A. Equipment Placement

Design teams need to be aware of the zoning restrictions on location of equipment used in projects. Consideration of noise production and aesthetics are just some of the issues at hand. New, more efficient units are often larger than the units that are being replaced. Programs may need to provide concrete pads and alter some landscape features to place HVAC equipment.

Without exception, units cannot infringe on property lines or be placed inside of setbacks. As unit efficiency increases, the equipment size increases, and it should not be assumed that the new units will fit in the old locations.

B. Flood Zones

Flood restrictions on equipment locations exist in coastal plains and low-lying areas of the country. Restrictions may require something as simple as an elevated pad in an area with minimal flood restrictions, or requirements may be a fully supported platform placing the equipment above the base of the first floor. In flood zones of this type, no ductwork is allowed in crawl spaces unless the bottom of the duct is above the maximum flood restriction height. Since SIPs typically deal with existing homes, this may require a significant consideration in the mechanical system location.

Coastal flood zones offer additional problems to unit location. In addition to flooding, there is often the problem of erosion. It is recommended that consideration be given to placing equipment on platforms attached to the home, on upper decks or landings, or on the roof.

C. Roof Versus Ground Pads

The difference between a ground-mounted unit and a roof-mounted unit is far more than location. It is common to have condensing units and outdoor sections of heat pumps mounted on the ground in areas where space is sufficient, vandalism is low, and other restrictions do not preclude it. However, some design considerations may necessitate an alternate location. Raised platforms as described in the flood section may be used to put a unit in a safer location when the roof is unavailable, inaccessible, or architecturally unsuitable for various reasons.

A concern with roof-mounted equipment is the wind load. Although condensing units and heat pumps have small footprints, they can have significant sail area. Units have flipped, twisted, and relocated during high wind storms, nor'easters, and hurricanes. Consideration of wind access to the equipment may necessitate structural supports and ties to prevent unit movement. Bolting, strapping, or some other means of restricting the movement of units during high winds may affect costs and design criteria.

7.8.6 Best Practice Recommendations: Additional Considerations

1. Deficiencies in existing buildings can create huge cost overages if not addressed in the developmental stages of an SIP.
2. Electrical upgrades and service changes require specific safety practices and need to be coordinated with utility contractors and customers before work begins.
3. Maintainable equipment must be accessible.
4. Install quality equipment and involve customer/owner in final choices for warranty options.
5. Location of outdoor equipment may require consideration of HOA restrictions, flood zones, building geography and structure, and environmental impact.

7.9 Institutional Properties

Institutional buildings vary in size and scope, from a one-room church to a community college. Institutional buildings are defined under codes and standards as commercial. Mechanical equipment is divided into two basic categories: light commercial and commercial. *Light commercial* covers equipment up to 50 tons capacity; *commercial* covers everything else. *Industrial* is a separate category and outside the scope of this document. ASHRAE 62.1 is the jurisdictional

standard for commercial ventilation in most districts, but local officials need to be consulted before any design considerations are put to paper. Necessarily, the mechanical issues for effective installation of residential systems and their proper protection against infiltration, contamination, and other issues are true for commercial systems. ASHRAE 62.1 divides the commercial sector into many categories, and each category has subdivisions. Some examples of the larger categories are correctional facilities; educational facilities; food and beverage service; hotels, motels, resorts, and dormitories; office buildings; public assembly areas; retail; and sports and entertainment. For one further example, the educational category has 13 subdivisions. Any SIP involving an institutional building will be significantly more complicated than one for the average residence.

It may be prudent in certain projects to exceed minimum design standards both within the envelope and when choosing the equipment serving the building. This is inherently clear when considering the impact of west-facing glass or multi-pane, heat-absorbing glass and when considering localities with extreme ambient conditions. In all cases, it is advised that the SIP team consider several factors before final decisions are set in concrete: up-front costs, long-term effects for minimizing envelope permeability, maximizing the aesthetic, and gaining maximum efficiency.

7.9.1 Ventilation for Acceptable Indoor Air Quality

Many of the IAQ issues and questions covered in Section 7.3 of this document are true for institutional buildings. One significant difference is the volume of air needed not just for occupancy comfort, but also for ventilation air. The commercial standard ASHRAE 62.1 does not concern itself with thermal comfort, which is contained in ASHRAE 55-2010. Existing buildings are also not part of the standard unless local jurisdiction makes inclusion mandatory, typically due to renovation, additions, or changes that fall under the standard. Since SIPs normally involve existing buildings, why review ASHRAE 62.1? As with all governing agencies, ASHRAE publications are guides subject to local jurisdiction. One significant method for superseding any local jurisdictional question is engineering a solution. It is important to remember that no standard will cover all possible situations. ASHRAE 62.1.2.3 notes, “Additional requirements for laboratory, industrial, health care, and other spaces may be dictated by workplace and other standards, as well as the processes occurring within the space.”

Section 4 of the standard outlines requirements that must occur prior to ventilation system design. The first discussed is regional air quality and whether the building area is in compliance with the National Ambient Air Quality Standards for each pollutant in Table 4.1 of the standard. The second is local air quality, which is an observational survey of the building site and surroundings during normal occupancy to check for local contaminants that may be a concern if allowed to enter the building. The final step is to document the observations and discuss them with the building owners. A list of observation points is given in ASHRAE 62.1.4.3.2.

7.9.2 Systems and Equipment

Intake inlets, exhaust outlets, penetrations, and routes are important considerations during the design phase of commercial buildings to stay in compliance with Table 5-1 and Section 5.3 of ASHRAE 62.1. There are also some exceptions and appendices that discuss intake and exhaust locations.

Mechanical ventilation equipment is commonly obtained as design-build from one of the major high-quality air-conditioning equipment manufacturers. The advantage of designed systems is the ability of the products to be packaged together. It is customary to have complete, self-contained units with intake fans, exhaust fans, heat exchangers, filtration, and any specialty

items all on one skid ready to install. If heating and cooling are part of the package, the units can usually be designed to fit together or even be factory-attached.

The most common ventilation practice in commercial equipment is to add an economizer or minimum outdoor air intake to packaged heating and cooling equipment. Typically, building pressurization is relieved by barometric dampers in roof vents or hoods. Economizers work similarly to intakes except that they are automatically adjustable based on building pressure. Economizers are often linked with mechanical exhausting of building pressure and tracked by operational controls.

Additional methods for addressing outdoor ventilation use heat exchangers of various types to recover building energy before exhausting. Common types of energy recovery products are desiccant wheels, heat tubes, air-to-air heat exchangers, and water-cooled heat exchangers. Whatever the system type, the goal is to remove energy from the building exhaust air and condition the ventilation air. Desiccant wheels use building air to dehumidify a membrane that rotates between the intake and exhaust sections of an air handler. When the incoming air comes into contact with the dehydrated membrane, it gives up moisture and some heat before entering the building. Heat tubes filled with refrigerant easily migrate under differing temperature conditions. The refrigerant moves between the intake and exhaust sections, alternately recovering and rejecting energy as it moves. Air-to-air heat exchangers are self-explanatory. Water-cooled heat exchangers have local reservoirs and pumps that move water over the inlet section of a typically plastic heat exchanger, cooling the ventilation air. This is not an exhaustive list, and new products are continually entering the market.

7.9.3 Indoor Air Quality

As mentioned in the residential section, IAQ is an emerging issue that has far-reaching impact. The design procedure for treatment of outdoor air and the subsequent conditioning of indoor air requires examination of air intake rates. In addition, a survey of possible local contaminant sources, contaminant concentration targets, and perceived acceptability targets should precede design decisions. ASHRAE 62.1 sets the design standard for IAQ systems as performance-based, intending to maintain concentrations of specific contaminants at or below limits specified during the design process. ASHRAE 62.1.6 details filtration procedures, product specifications, contaminant standards, and distribution zone standards. Table 6-2 of the standard outlines measurements for air-zone distribution effectiveness. Section 7 of the standard covers construction issues, and Section 8 looks at humidification and some general operational and maintenance issues.

7.9.4 Best Practice Recommendations: Institutional Properties

1. Commercial buildings require professional engineering to meet the demands of properly designed sound insulation treatments in conformance with local code compliance.
2. Do not overlook intakes and exhaust locations for or around new equipment. New code requirements often necessitate revising exhaust piping of an existing building.
3. Maintaining indoor air quality in commercial buildings varies largely by use; therefore, detailed information regarding building operation and purpose will be considered when choosing a ventilation strategy.



CHAPTER 8

Green Initiatives

Issues come and go with the political winds. But in these superficial exchanges, we often lose sight of the real and lasting meaning of the decisions we make and those we defer. The issue of climate change is one that we ignore at our own peril. There may still be disputes about exactly how much we're contributing to the warming of the earth's atmosphere and how much is naturally occurring, but what we can be scientifically certain of is that our continued use of fossil fuels is pushing us to a point of no return. And unless we free ourselves from a dependence on these fossil fuels and chart a new course on energy in this country, we are condemning future generations to global catastrophe.

— President Barack Obama, 2006¹

The building sector is responsible for a significant proportion of resource consumption in the United States, including 42% of primary energy use, 72% of electricity consumption, 39% of greenhouse gas emissions, 60% of waste output, and 13.6% of potable water consumption.

While sound insulation programs are not, by design, energy efficiency or thermal improvement programs, minimizing sound transmission through the building envelope can simultaneously improve a building's energy and acoustical performance. Efficiency opportunities applicable to an SIP include using energy-efficient fenestration products, lowering energy usage for ventilation systems, and minimizing air (and therefore thermal) infiltration. SIP efforts are in line with the general market trend toward better-performing buildings. Current and rapidly evolving sustainability practices, including recycling and use of green building products, need to be a part of every SIP's response to environmental and community concerns beyond noise.

8.1 Sustainable Building Design

8.1.1 Federal Mandate

Energy efficiency is the fastest, cheapest, and cleanest energy resource we have. Efficiency is not conservation or deprivation; it is getting what you want for less. Efficiency saves consumers and businesses money on their energy bills, reduces global warming pollution, and keeps American energy dollars here. America has the largest efficiency reserves in the world, and buildings are our largest source of efficiency that is just waiting to be tapped.

— Natural Resource Defense Council²

Policy makers at the federal level have long recognized the importance of promoting energy efficiency. Within the U.S. DOE, the Office of Energy Efficiency and Renewable Energy (EERE) is devoted to promoting market transformation in this area. EERE recommends that a residential remodeling project begin with a home energy assessment or home energy audit. The DOE also

¹ Barack Obama, Energy Independence and the Safety of Our Planet (speech, April 3, 2006).

² Natural Resources Defense Council, Energy Facts: Unlocking the Power of Energy Efficiency in Buildings, accessed January 2012, <http://www.nrdc.org/energy/unlocking.pdf>.

oversees the Energy Star program and appliance SEER ratings. Weatherization programs and minimum standards for energy efficiency were prominent aspects of the Emergency Economic Stabilization Act of 2008. With the publication of the IgCC in March 2012, future federal policy may result in mandatory code requirements for sustainability in commercial and mixed-use or high-rise residential projects.

Section 104 of the Energy Policy Act of 2005, Procurement of Energy Efficient Products, requires that each agency:

incorporate into the specifications for all procurements involving energy consuming products and systems, including guide specifications, project specifications, and construction, renovation, and service contracts that include provision of energy consuming products and systems, and into the factors for the evaluation of offers received for the procurement, criteria for energy efficiency that are consistent with the criteria used for Energy Star products and for rating FEMP [Federal Energy Management Program] designated products.³

While this policy focuses on federal procurement for federal properties, using Energy Star practices and products can imbue federally funded SIPs with the same standards the DOE applies to FAA property.

Because conservation serves multiple interests, from environmental protection to national security, the U.S. government is leading the way by requiring sustainable construction for federal projects. It is anticipated that sustainable practices will, over time, be increasingly addressed during the standard 3-year code development cycle for national building codes. The extent and timing of any mandatory sustainability practices for construction projects cannot be predicted; however, there is good reason to believe new regulations are inevitable. In the meantime, there are excellent reasons to pursue sustainable outcomes in all projects, regardless of size, because the savings from conservation efforts accrue directly to the property owner as well as to the utility company and the environment.

8.1.2 Financial Incentives

Because the demand for power continues to grow, utility and government authorities now offer incentives for energy reduction and alternative power generation in order to reduce expansion of expensive power infrastructures. These incentives for energy efficiency can include rebates, grants, and loans as well as personal, property, sales, and corporate tax credits. The availability of these incentives as offered by federal, state, or local governments or by utility companies varies depending on project type and locality.

The first step in achieving a maximally sustainable outcome for an SIP is to identify any local, regional, utility, and federal incentive programs that could apply. Program policy and procedure decisions made during the program start-up phase should be informed by potential benefits from rebates, tax credits, and financial grants. For example, upgrades in ventilation and air conditioning can require neighborhood transformer upgrades on the part of the utility. At the time of publication of these guidelines, at least one sound insulation program is taking advantage of energy rebates offered by the utility company to encourage use of efficient equipment. It is recommended as a best practice that other SIPs do so as well.

8.1.3 Development of Sustainable Practices

Sustainability in general and energy efficiency in particular are aspects of building design, construction, and operation that are receiving increasing attention. Following the oil embargo

³42 USC 8259b.

and resulting spike in energy prices of the late 1970s, the discipline of building science increased its focus on the building envelope as a principal factor in energy performance. In the 1960s and 1970s, environmental engineers began exploring ways of designing and building in more sustainable ways. These efforts ultimately led to the creation of codes and standards that included sustainability standards. Some of the most widely promulgated codes and standards are discussed in the following.

LEED. In 1998 the first United States Green Building Council (USGBC) LEED rating system expanded the scope of sustainability in building design and construction to include site selection, water efficiency, materials and resources, and indoor environmental quality. Designed as a voluntary incentive-based program, projects are awarded different levels of certification based on total points achieved in all categories of sustainability. As the LEED systems have evolved, the program incorporated an emphasis on achieving a minimum level of energy conservation. Certain jurisdictions and organizations have experimented with establishing LEED as a mandatory standard; however, this does not coincide with the intent of the USGBC's voluntary approach to sustainability. The number and scope of LEED rating systems have expanded to include neighborhood development and existing buildings (see full listing in Section 8.2.2).

ICC-700. In 2008 the ICC and the National Association of Home Builders (NAHB) produced an ANSI-approved standard called the National Green Building Standard, establishing criteria for rating the environmental impact of low-rise residential design and construction. Because of the pre-existing commitment with NAHB to develop ICC-700, the ICC could not include low-rise residential construction in the IgCC.

IgCC. The ICC, in cooperation with the American Institute of Architects, the Illuminating Engineering Society, and ASTM, developed the IgCC. The USGBC and ASHRAE also became participants and co-sponsors during the development process. The ICC began development of the IgCC in 2009, with an anticipated jurisdiction over commercial and high-rise residential construction. The early public versions of the IgCC underwent code amendment hearings in 2010, and several jurisdictions have adopted the code. In March 2012, the ICC published the IgCC as an integral member of the family of international codes. Adoption of the IgCC over the coming years will mark a fundamental shift in how commercial/institutional buildings are designed, constructed, and renovated.

Development of the IgCC significantly furthers the process of market transformation begun by the early innovators of the 1970s and 1980s and by the USGBC's systems for LEED certification. The requirements of the IgCC follow the format of an LEED checklist, with chapters entitled Site Development and Land Use; Material Resource Conservation and Efficiency; Energy Conservation, Efficiency and Atmospheric Quality; Water Resource Conservation and Efficiency; Indoor Environmental Quality and Comfort; Commissioning, Operation and Maintenance; and Existing Buildings. While the IgCC does not currently include requirements for low-rise residential construction due to the pre-existing development of ICC-700, this may change over the coming years as adoption and enforcement of this code becomes more common. Encouraging and incentivizing energy conservation and sustainability has made the development of a mandatory green code a possibility.

8.1.4 Developing Sustainable Sound Insulation Practices

With all of the conversation surrounding sustainability in the design and construction industry, it is advisable to identify opportunities for effective sound insulation guidelines that incorporate environmentally aware practices. Application of sustainable practices will depend in part on the extent of work required to achieve effective noise mitigation. The installation of sound

insulation and new windows and doors for acoustic purposes has implications for the thermal performance of the building envelope. Modifications to the building envelope that result in reduced infiltration and exfiltration must also address moisture migration, space conditioning, and indoor air quality. Project managers should use appropriate sustainable building practices for all aspects of construction.

An energy audit of a structure prior to undertaking a sound insulation project will identify noise paths through the building's exterior envelope (i.e., walls and roof). In addition, the audit can pinpoint air/noise points of infiltration at fireplaces, attic hatches, and wall- or window-mounted air conditioners. The audit can also help determine the efficiency of the existing heating and air conditioning units and associated ductwork to help determine whether repair, modification, or replacement is advisable. It is possible to position SIPs for incentives from energy efficiency programs, for example from utility providers, by developing practices to quantify energy savings from program treatments.

8.2 Energy Rating Programs

While building codes represent minimum standards applicable to all construction, rating systems and voluntary standards provide opportunities for experimentation and market transformation. Key stakeholders in SIPs need to be aware of the variety of codes and standards that address energy and environmental performance in order to address concerns raised by program participants and the regulatory authorities that have oversight of SIPs. What follows is a list of the major programs and rating systems most widely used as of the publication of these guidelines.

8.2.1 Energy Star

The EPA's Energy Star program includes requirements for residential renovations, additions, and new construction. A key feature of the Energy Star program is its Complete Thermal Enclosure System, which involves air sealing, properly installed insulation, and high-performance windows. Also emphasized are efficient cooling and heating, proper design and quality installation practices, and whole-house mechanical ventilation. A complete water management system is achieved by means of water-managed construction details and proper storage and handling of building materials. Energy-efficient lighting and appliances complete the scope of the program. Compliance is monitored via third-party verification (the Home Energy Rating System, or HERS).

As national programs, Energy Star and HERS are the most widely available and consistent systems used to evaluate home energy performance that exceeds code requirements. Energy Star is also the base standard for determining qualification for many of the energy rebates available today. As such, it is a best practice recommendation of these updated guidelines that SIPs create policies and procedures for products and installations that meet Energy Star performance criteria.

8.2.2 LEED

The USGBC developed the LEED rating system as a readily comprehensible and usable method for integrating and evaluating sustainable principles into building design, construction, and operation. Thirty percent of all LEED-certified projects are government owned, and it is likely that eventually most government-sponsored construction projects will be mandated

to address sustainable practices. The LEED system has evolved to include the following ten systems:

1. LEED for New Construction
2. LEED for Core and Shell
3. LEED for Schools
4. LEED for Retail: New Construction and Major Renovations
5. LEED for Retail: Commercial Interiors
6. LEED for Healthcare
7. LEED for Commercial Interiors
8. LEED for Existing Buildings: Operations and Maintenance
9. LEED for Neighborhood Development
10. LEED for Homes (see Section 8.2.3)

Each system offers different levels of certification based on the number of points achieved. The certification levels are Certified, Silver, Gold, and Platinum, indicating the level of commitment to and investment in sustainable construction. Building owners from institutions, private industry, and the government have seen the value of LEED in operational cost savings and industry status. Certain businesses and government departments have set standards regarding which level of LEED they will accept in spaces they will rent or build. To achieve LEED certification, a given project must be registered with the USGBC. Certification requires the involvement of at least one LEED-Accredited Professional or LEED Green Associate on the project team. Although it is possible to use the rating systems as a guide to sustainable practices, without the verification of the certification process, quality control cannot be guaranteed.

While LEED practices include many aspects of new construction or building maintenance that are beyond the scope of SIPs, several categories are applicable. These include materials and resources, energy and atmosphere, indoor environmental quality, and regional priorities.

8.2.3 LEED for Homes

The LEED for Homes rating system was released in January 2008 as part of the LEED rating system. This system awards points for:

- Innovation and design process,
- Location and linkages,
- Sustainable sites,
- Water efficiency,
- Energy and atmosphere,
- Materials and resources,
- Indoor environmental quality, and
- Awareness and education.

As with the other LEED systems, a project can pursue points to achieve the different levels of Certified, Silver, Gold, or Platinum. Inspection with testing is a required part of the certification process. Projects characterized as “substantial gut/rehab” can participate in LEED for Homes as long as they meet all of the program’s prerequisites. In order to qualify as a “substantial gut/rehab,” a project must replace most of the systems and components (e.g., HVAC, windows) and must open up the exterior walls to enable the thermal bypass inspection to be completed.

At this point, the normal scope of sound insulation is not robust enough to achieve this certification; however, the concepts in the last four of the eight categories can be applicable

to forming sustainable practices. Research into these last four categories will provide opportunities for SIPs to implement more sustainable practices. For example, under indoor environmental quality, LEED certification points are awarded for items that are all applicable to SIPs, including:

- Using the Energy Star Indoor Air Package to address indoor air quality and for heat recovery systems,
- The provision of outdoor air,
- Having air balance testing conducted, and
- Providing local exhaust systems.

8.3 Sustainability Codes and Standards

The process of responding to new scientific and community environmental concerns begins with innovation and often leads to the development of mandatory codes and standards. For sustainable construction, this process is still under way. Listed in the following are the current industry group documents that are being adopted in model codes of many jurisdictions where SIPs are being implemented.

8.3.1 ICC 700-2008: National Green Building Standard

The ICC entered into an agreement with the NAHB to develop ICC-700, which included a proviso preventing the ICC from developing any code or standard that could compete with this document. This National Green Building Standard can be adopted by a jurisdiction to provide criteria for evaluating the environmental impact of design and construction practices for low-rise residential buildings, residential remodeling projects, and site development projects. It provides flexibility for regionally appropriate, best green practices.⁴ The standard covers “subdivisions, building sites, alterations, additions, renovations, mixed-use residential buildings, and historic buildings.” Points are allocated based on the degree of compliance with each sustainable practice described. Performance level points determine the project’s level of achievement; in ascending order these are bronze, silver, gold, and emerald. Thresholds for specific practices are applied to renovations and additions. The standard is intended to provide a flexible method for achieving environmental performance.

8.3.2 CAL Green: California Green Building Standards Code (Title 24 Part 11)

The California Green Building Standards Code (CAL Green) went into effect statewide in January of 2011. It is intended to apply to new construction only, but several jurisdictions have adopted it for use in renovations of existing buildings as well. It is a comprehensive code intended to promote the use of building practices with a reduced negative impact or positive environmental impact. It encourages the use of sustainable construction practices. The provisions are divided between residential and nonresidential construction. The residential requirements are applicable to one- and two-family dwellings and multifamily residential buildings of three stories or fewer. All other building occupancies are considered to be nonresidential.

⁴ICC 700, National Green Building Standard, NAHBGreen, accessed January 2012, <http://www.nahbgreen.org/NGBS/default.aspx>.

Mandatory measures for residential construction that are applicable to SIPs include:

Energy Efficiency

- Meet or exceed the 2010 California Energy Code.

Material Conservation and Resource Efficiency

- Seal penetrations at exterior walls for piping and conduits.
- Divert 50% of construction waste from disposal by recycling or salvaging materials.
- Provide a building operations and maintenance manual to the owner.

Environmental Quality

- Fireplaces to be direct vent; wood stoves to meet EPA Phase II emissions limits.
- Seal ducts during construction to keep them clean.
- Use low VOCs and low toxicity paints and sealants.
- Use low-VOC carpeting and floor coverings.
- Use particle board, medium-density fireboard, and plywood low in formaldehyde emissions.
- In order to prevent mold, do not install building materials exposed to water over an established moisture content level.
- Provide exhaust fans in each toilet room.
- Insulate dampers on whole-house exhaust fans.
- Size HVAC ducts and mechanical systems appropriately using industry standards.
- Use qualified installers and inspectors trained in the discipline in which they are working.

CAL Green contains a series of mandatory measures for each of the two occupancy groups listed in the code divisions. In addition, there are additional measures that can be adopted by the local jurisdiction to increase the stringency of the code. For example, the basic energy code requirements of the very stringent California Energy Code meet the mandatory measures of CAL Green. CAL Green's voluntary measures have two tiers of enhanced requirements. Tier 1 requires a 15% improvement in energy efficiency over the California Energy Code. Tier 2 requires designs to exceed the California Energy Code by 30%.

The additional voluntary provisions are intended for adoption by local authorities having jurisdiction. They include many innovative items, such as cool-roof reflective membranes, reduced air losses through the use of blower-door tests of envelope tightness, building commissioning of systems for high-performance operations, rainwater capture systems to reduce water use, reduced cement content in concrete through the use of fly ash, use of recycled building materials or materials with a high recycled content, and installation of higher-value MERV (minimum efficiency reporting value) filters to improve indoor air quality.

8.3.3 The IgCC

The IgCC was developed as an overlay code, meaning that it is coordinated and consistent with the layout and requirements of the other ICC model codes. It includes provisions for all dimensions of sustainability in the format of a code; however, it does not apply to low-rise residential construction (i.e., one- and two-family dwellings and townhouses) due to the prior development of ICC-700 for this purpose.

The code is structured with mandatory requirements; however, there are also additional electives that can be chosen either by the adopting jurisdiction or the project team. Each chapter includes a list of these electives. The adopting jurisdiction has the authority to mandate any of these electives (jurisdictional requirements) and also can require from one to 18 project electives be chosen by the project team. These electives add a level of flexibility and regional adaptability to the IgCC while allowing for different levels of compliance. The IgCC is the first code to

incorporate the broad parameters of a sustainable approach to design and construction. While two public versions of the IgCC have been released and several jurisdictions have adopted part or all of these versions, the code is likely to achieve a higher level of visibility with its publication as part of the 2012 family of ICC codes.

8.3.4 ASHRAE 189.1, Standard for the Design of High-Performance, Green Buildings Except Low-Rise Residential Buildings

ASHRAE's green building standard was released in 2010 to address enhanced energy efficiency as well as site sustainability, water efficiency, indoor environmental quality, and a building's impact on the atmosphere and natural resources. Many of these areas of focus provide multiple compliance options. ASHRAE 189.1 is a compliance alternate in the IgCC and is intended to be used in conjunction with:

- ASHRAE/IESNA Standard 90.1, Energy-Efficient Design of New Buildings Except Low-Rise Residential Buildings,
- ASHRAE Standard 62.1, Ventilation for Acceptable Indoor Air Quality, and
- ASHRAE 55, Thermal Environmental Conditions for Human Occupancy.

As stated in the standard, the intent is:

to provide minimum requirements for the siting, design, construction, and plan for operation of high performance, green buildings to:

1. Balance environmental responsibility, resource efficiency, occupant comfort and wellbeing, and community sensitivity; and
2. Support the goal of development that meets the needs of the present without compromising the ability of future generations to meet their own needs.

8.3.5 Local Municipal Codes

Energy requirements in construction are somewhat of a moving target, and many municipalities are striving to be increasingly energy efficient. Therefore, it is important to review local statutes for stricter requirements than what may be in the state-adopted model code. As an example, Massachusetts permits its municipalities to adopt "stretch codes" allowing more stringent requirements, by up to 20% above what is called for in the Massachusetts State Building Code:

The "stretch code" is an optional appendix to the Massachusetts building energy code that allows cities and towns to choose a more energy-efficient option. This option increases the efficiency requirements in any municipality that adopts it, for all new residential and many new commercial buildings, as well as for those residential additions and renovations that would normally trigger building code requirements.⁵

This code allows cities and towns to adopt more stringent requirements, by up to 20% above what is called for in the Massachusetts State Building Code.

Energy Star compliance has also been incorporated into state energy efficiency programs, such as for residential construction under the Massachusetts Stretch Code.

The residential stretch code is based on the pre-existing "Energy Star for Homes" program developed by the federal EPA and Department of Energy, and customized for Massachusetts. This Energy Star program incorporates the Home Energy Rating System (HERS) which is developed and administered by the national Residential Energy Services Network (RESNET).⁶

⁵ Stretch Appendix to the Building Energy Code in Massachusetts Question and Answer (Q&A) – August 2010, City of Boston, accessed January 2012, http://www.cityofboston.gov/Images_Documents/EOEEA%20q_and_a_stretch_code_tcm3-21504.pdf.

⁶ Stretch Appendix to the Building Energy Code in Massachusetts Question and Answer (Q&A) – August 2010, City of Boston, accessed January 2012, http://www.cityofboston.gov/Images_Documents/EOEEA%20q_and_a_stretch_code_tcm3-21504.pdf.

Existing homes undergoing renovation or an addition have two choices when it comes to stretch code compliance. The performance option requires a minimum HERS rating as well as confirmation of performance by means of the Energy Star Thermal Bypass checklist. Energy Star windows, doors, and skylights are required where replacements are made. The prescriptive option references the IECC 2009 model energy code. If the prescriptive option is chosen, then code compliance is required only for the systems being replaced.⁷

8.3.6 Best Practice Recommendations: Sustainability Codes and Standards

1. Compliance with mandatory codes and standards within a project's jurisdiction constitutes the minimum responsibility of a property owner. Few jurisdictions currently require mandatory compliance with sustainability codes for all projects. The codes and standards described under Section 8.3 have been implemented as optional, or in order to qualify for incentives such as additional floor area ratio, or for expedited permitting.
2. In some jurisdictions, a sustainable code or standard may have been adopted as a stretch code. This is the case in Maryland, where any jurisdiction may choose to adopt the IgCC as a mandatory code. However, in most jurisdictions, compliance with the sustainability codes and standards described previously is not yet required.
3. Determine what incentive programs are available, perform energy audits of existing buildings' compliance with applicable codes, and provide sound insulation using products and installations that meet Energy Star performance criteria.

8.4 Current Program Practices for Sustainability

The central lesson of the science of ecology is the interrelationship of systems and processes. If a building envelope is made airtight for sound attenuation reasons, mechanical ventilation will be required in order to ensure indoor air quality. If mechanical ventilation is added to a building's systems, heating and air conditioning are required to ensure that indoor conditions remain tenable. If mechanical equipment is mandated for air quality reasons, it should be efficient with beneficial life-cycle prospects, both for economic and environmental reasons.

This section identifies sustainability practices currently used in SIPs across the country. Not all programs use all practices. The following lists of strategies should be considered when relevant to the scope of work being performed.

8.4.1 Materials

All materials specified for construction projects have sustainability implications. These include all aspects of the life-cycle process as well as actual performance and embodied energy. Attention to the

⁷ Stretch Appendix to the Building Energy Code in Massachusetts Question and Answer (Q&A) – August 2010, City of Boston, accessed January 2012, http://www.cityofboston.gov/Images_Documents/EOEEA%20q_and_a_stretch_code_tcm3-21504.pdf.

life-cycle implications of a remodeling project will yield both environmental and economic benefits. Currently used practices include:

- Reuse building materials, including windows and doors.
- Specify insulation made from recyclable materials (minimum 20% post-consumer recycled content with low or no formaldehyde emissions).
- Contractor should provide waste management plan with salvage and recycling of demolished products.
- Specify materials extracted, manufactured, and produced within a 500-mile radius.
- Tropical hardwoods, if produced, must be Forest Stewardship Council certified.

8.4.2 Energy and Atmosphere

Sound attenuation through modifications to the building envelope will also improve energy performance. Where HVAC systems are installed or modified, further opportunities exist for efficiency and conservation. Reduced energy costs for the property owner are an obvious benefit. Reduced carbon emissions are an additional social benefit. Currently used practices include:

- Use NFRC-labeled windows.
- Add insulation to wall cavities around windows.
- Add insulation to roofs/ceilings.
- Add insulation to crawl spaces, windows, and door jambs.
- Increase insulation level to R-30 minimum (above the average of R-15).
- Pressure test ducts to identify and repair air leaks.
- Install high SEER-rated equipment.
- Meet Energy Star with Indoor Air Package requirements.
- Provide dedicated outdoor air system with heat recovery.
- Use multispeed blowers.
- Use programmable thermostats.
- Provide acoustic baffles with rigid insulation.
- Provide economizers with CO sensors.
- Provide ceiling fans.
- Provide timer/automatic controls for bathroom exhaust fans.

8.4.3 Indoor Air and Environmental Quality

A tighter building envelope results in reduced noise transmission, improved energy performance, and the potential for indoor air quality problems. The health of building occupants is at stake. Indoor environmental quality must be addressed as part of any SIP. See Chapter 7 for further information. Currently used practices include:

- Protect equipment and ducts during construction against entry of foreign matter.
- Use environmentally safe products.
- Specify low to no VOC materials.
- Specify low to no formaldehyde materials.
- Place no air handling equipment or return ducts in garage.
- Tightly seal shared surfaces between garage and home.

8.4.4 Commissioning and Maintenance

Building systems require commissioning and maintenance. Performance cannot be delivered without careful testing, calibration, and ongoing monitoring. Currently used practices include:

- Provide operation and maintenance manual(s) and instructions.
- Perform systems balancing and testing for air leaks.

- Perform blower-door testing to identify and treat air leaks.
- Provide third-party testing of outdoor airflow rate into home.
- Provide third-party testing of exhaust airflow rate out of home.
- Provide third-party testing of particulates and VOCs before occupancy.
- Conduct third-party testing for duct leakage.
- Conduct third-party testing of insulation installation.
- Meet Energy Star for Homes third-party testing.

8.4.5 Best Practice Recommendations: Program Practices for Sustainability

1. Determine any incentives, rebates, or grants that may be available for efficiency upgrades.
2. Perform a thorough energy audit of the property to determine systems efficiencies and potential areas for improvements.
3. Comply with all applicable codes in the jurisdiction governing the SIP.
4. Provide sound insulation treatments with products and installations that meet Energy Star performance criteria.
5. Identify additional opportunities/strategies from Section 8.4 or from any of the energy rating standards described in this chapter.



CHAPTER 9

Product Development

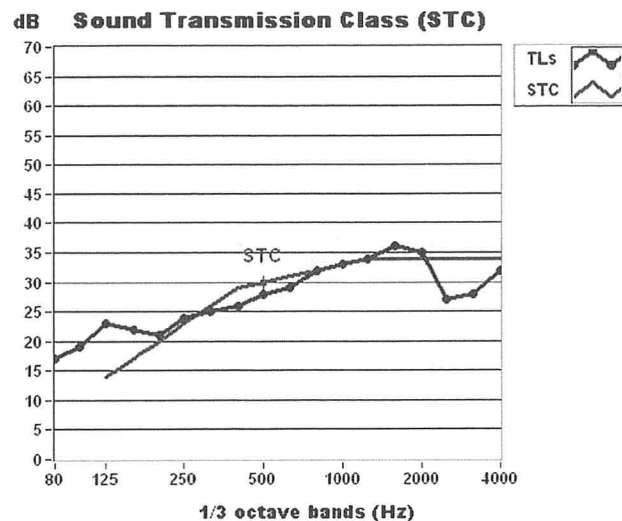
When sound insulation programs began in the 1980s, there were few stand-alone window or door products available to the residential renovation market that were designed to reduce noise infiltration. Working with manufacturers and acoustical consultants, individual products were combined to meet sound attenuation goals. Several manufacturers have expanded their offerings to include integrated products that meet the needs of sound insulation and pass the standards for the fenestration industry. This has provided the acoustical fenestration market with performance-enhanced acoustical window and door products that accommodate varying conditions across the country. This chapter deals primarily with residential products; however the performance rating standards discussed are the same as those used to categorize institutional-grade products used in schools and other public buildings. The standards recommended for schools and so forth may be at a higher level in the rating system in order to meet the performance needs of larger fenestrations. Many of the manufacturers that provide products for residential SIPs also provide products for institutional SIPs.

9.1 Design Attributes of Acoustical Products

Design attributes of residential acoustical windows and doors vary from their conventional counterparts. Acoustical windows and doors are engineered using the acoustic principles of added mass, material combinations, weather seals, and sometimes additional air space configurations to enhance their overall acoustical performance. Despite these differences in acoustical design, the end product is intended to be one that homeowners recognize as residential in appearance and functionality.

9.1.1 Incorporation of Greater Mass and Decoupling

As discussed in Chapter 4, the thickness, weight (mass), and decoupling of a building system contribute to its ability to reduce sound transmission. Acoustical fenestration products combine greater mass into their assemblies in several ways. Manufacturers generally increase the overall frame depth of the acoustical product. This allows for heavier frame profiles and the use of larger, multichambered extrusions that provide additional sound dampening characteristics. Some manufacturers combine various base materials that, when fabricated into a finished frame assembly, help dampen or flatten the coincidence effect while enhancing the overall STC performance curve. The coincidence effect, or critical frequency of a material, is defined as the acoustical frequency at which the length of the sound wave traveling through the material is equal to the length of the sound wave traveling through air. The closer the sound waves, or frequencies, are to the critical frequency, the more readily they pass through the material surface. What does this mean for acoustical window and door manufacturers? Materials used in the manufacturing



Courtesy of SCS/Larson.

Figure 9.1. Coincidence effect.

of acoustical window and door products have varying degrees of stiffness. The stiffness of a material or assembly of materials creates a sometimes pronounced dip in particular frequency ranges in the transmission loss graph. This is known as the coincidence effect (see Figure 9.1). Depending on the severity of the effect, this can lead to notably reduced sound dampening and lower overall STC results. Although most materials or combinations of materials have a coincidence dip, the goal of the window or door designer is to shift the coincidence effect up or down, out of the frequency range that can decrease STC results. This effectively flattens the coincidence effect and increases the overall sound attenuation of the window or door product. This flattening can sometimes be accomplished by the use of varying frame materials, increased air spaces, and multiple glass thicknesses and glazing materials. Each manufacturer determines the best combination of materials to shift the coincidence dip to increase the sound attenuation of the product at certain critical frequencies.

Wider window frames allow for the application of a primary and secondary sash system. This dual-window design provides larger air spaces between the glass surfaces and allows for the use of various glass thicknesses and glass combinations. These designs greatly reduce the sound transmission through the system.

Acoustical door systems add considerable mass to the core of the door slab assembly. The weight of acoustical door assemblies varies from approximately 7.5 lbs/ft² to 8.0 lbs/ft² to as much as 12 lbs/ft² to 14 lbs/ft². The sound dampening characteristics of the door system have a direct correlation to the mass of the core assembly. Manufacturers add additional sound deadening materials, many of which are listed as proprietary, to the core construction to further enhance performance. Acoustical patio door systems derive additional mass through the use of multiple layers of heavy sheet glass combined into a sealed insulated glass (SIG) unit. Heavier extrusions and reinforced frame profiles are required to support the additional weight of the glazing materials, adding additional sound dampening performance.

9.1.2 Material Choices

Acoustical fenestration products are fabricated from a number of material choices. For windows, this includes extruded aluminum frames and sash incorporating a thermal barrier design, extruded vinyl profiles with welded frame and sash components, composite products incorpo-

rating a combination of extruded aluminum profiles and extruded vinyl profiles assembled into a finished system, and wood and clad wood fenestration products designed with a secondary window or storm window applied.

Acoustical entrance door systems are manufactured with steel, fiberglass, solid core wood, and wood-veneered skins over a variety of core materials to produce a wide range of STC performance values. Acoustical patio door systems are fabricated of thermally improved extruded aluminum profiles, extruded vinyl (PVC) materials, and wood and clad wood profiles. Although aluminum and vinyl acoustical patio doors provide high STC values as stand-alone assemblies, wood and clad wood patio door systems are currently combined with secondary storm door products to produce the required STC performance.

9.1.3 Features and Aesthetic Attributes

With the many acoustical window systems that are available come a wide variety of features and aesthetic attributes that allow SIPs to closely match the appearance, operation, and materials of the windows being replaced (see Figure 9.2). Acoustical fenestration products offer many of the same features and benefits found in their conventional counterparts. For example, frames and sashes are manufactured from low-maintenance materials. Wood and clad wood frame components allow designers to match windows replaced in wood window markets and in historic structures. Operating window sashes are counterbalanced and easily removable to the interior. Some manufacturers offer tilt features that allow the sash to tilt in for cleaning and maintenance. This system helps reduce the weight the owner must support while performing routine service. Glazing options, which include high-performance glazing films, gas-filled air spaces, and tinted or reflective glass packages, provide best-fit solutions for the various geographic locations and



Courtesy of SCS/Larson.

Figure 9.2. *Acoustical replacement window.*

climates of SIPs. Many manufacturers of acoustical products offer exterior and interior trim profiles, accessory components that provide a similar profile appearance to original windows, and solutions to installation issues encountered in the field.

Acoustical entry door systems are similar in appearance to conventional swinging door systems and offer product features and material finishes comparable to standard door assemblies. Features such as panel designs, assorted glass-lite configurations, and secondary door systems can be applied to achieve a visual appearance similar to the door system being replaced. Acoustical doors can also be prepped to receive traditional hardware and lock-set assemblies. Aluminum and vinyl acoustical patio door systems are now available as stand-alone replacement doors, alleviating the need for the application of a secondary door system. These acoustic patio doors provide the homeowner with a full-lite, single door assembly capable of providing the acoustical values needed to satisfy most SIP requirements. Such door systems have provided a much-needed design approach to the replacement of patio doors in markets where the application of a secondary door is not widely accepted.

9.1.4 Weather Stripping and Weather Seals

Weather stripping and weather seals are important components of the acoustical design. Limiting the air infiltration, and therefore sound infiltration, at the perimeter seal is crucial to the overall acoustical performance of the product. Acoustical fenestration products with marginal weather seals generally experience greater deficiencies in performance, particularly with high-frequency sound waves. Acoustical fenestration products use multiple layers of weather stripping at the main frame and sash connection, along with interlocking profiles at the meeting rails. Most vertical sliding windows or hung windows, and horizontal sliding windows and doors, use a pile-type weather seal with an integrated polypropylene fin. The integrated fin helps keep the filament fibers tall, even in wet conditions. This type of weather stripping causes less friction and requires a lower operating force when used in sliding window configurations.

Foam-filled compression-type weather seals are ideal for use in swing doors and projected or casement windows. Many acoustical swing door and casement window designs use compression-type weather stripping. This type of weather stripping is made up of closed-cell urethane foam encapsulated in a polyethylene or vinyl cladding; this stays extremely flexible and is UV-stabilized. The foam-filled design compensates for sealing against irregular surfaces, providing superior sound attenuation and overall sealing performance. Closed-cell urethane has excellent compression recovery and set resistance.

9.1.5 Window Glazing Combinations and Air Space

Glazing packages and air spaces vary based on the manufacturer's engineered designs and fabrication techniques. Although there is a relationship between sound attenuation and air space, it is not the only design factor to consider and is not the sole consideration in determining a product's performance or eligibility. The air space between glazing surfaces varies depending on the acoustical window manufacturer and overall product design. In recent years, manufacturers have developed frame and sash assemblies made up of various base materials, which when assembled into finished fenestration products provide enhanced sound dampening characteristics. By increasing the product's performance with these engineered component parts, manufacturers have been able to reduce the overall thickness of products (making them easier to install in residential walls) while still meeting the STC performance requirements of SIPs. Product type, glass thickness, glazing materials, frame materials, weather stripping, and assembly techniques all contribute to the overall acoustical performance of the product. Recent independent product testing has indicated that many variations in air spaces, many under 2 in., can provide

STC results of STC 40 and above. Before approving any acoustical window or door product for an SIP, it is important to conduct a thorough product review for performance and compliance with program requirements, including analysis of fabrication information, assembly materials, glazing configuration, and independent test reports from a certified lab.

A. Monolithic Glass

Acoustical dual-window designs offer various glazing combinations that provide a range of acoustical performance. One option is the application of single-glazed monolithic or laminated glass, glazed in both the primary and secondary sash. This system allows for the use of heavy sheet glazing materials in a non-insulated glass configuration. Considerable mass can be added to the system, while the monolithic glass sheets provide the maximum air space available between the primary and secondary sash glass surfaces. STC results vary widely depending on glass thicknesses used; performance ranges from STC 38 to STC 47. This type of glazing package, in conjunction with extruded aluminum frames, is a good application for educational and other commercial applications. The use of monolithic glass in both the primary and secondary sash should be reviewed by geographic region for applicable energy code compliance. Such glazing configurations may not provide the necessary thermal performance required in all regions of the country. Thermal, reflective coatings are available for monolithic glass, but they need to be hard and non-scratchable.

B. Sealed Insulated Glass

The addition of a SIG unit in the prime sash, in combination with a single-glazed secondary sash, provides a triple glazing effect. The SIG unit allows for the use of soft-coat low-E coatings, gas-filled air spaces, and tinted or reflective glass packages to enhance the window's thermal performance. This system allows for the use of various glass thicknesses to enhance STC performance and create multiple and varying air spaces that help reduce coincidence effects. STC results of 40 to 44 can be achieved without the use of laminated or heavy sheet glass. This type of glazing can be easily serviced and readily available to homeowners at a reasonable cost if and when glass replacement is required. Heavy sheet glass and laminated glass can be glazed into the system if additional sound attenuation, enhanced safety, or additional performance is required.

C. Laminated Glass

The use of laminated glass can enhance the sound attenuation performance of the window or door system. The most common laminated glass product used in fenestration products consists of a nominal 1/4-in. overall glass thickness, made up of two sheets of 1/8-in. annealed glass, separated by a 0.30-in. (0.76-mm) PVB interlayer. PVB is a plastic film made of polyvinyl butyral. The PVB bonds the individual pieces of glass together, creating what appears to be a single sheet of glass. This interlayer provides between 1 dB and 4 dB of sound dampening to the glass sheet, depending on material, thickness, and ambient temperature. This dampening effect has a major impact on the sound transmission properties at high frequency levels and helps to considerably dampen or flatten the coincidence effect or critical frequency. It is important to note that at lower frequencies, the PVB interlayer or laminate provides no additional sound attenuating affects verses annealed glass of the same overall thickness. At low frequencies, such as those generated by airplanes, performance is generally controlled by the weight of the glass.

Laminated glass may address other issues in hurricane impact regions or locations needing additional security. Although laminated glass cracks on impact much more easily than tempered glass, the PVB interlayer helps prevent the glass from separating when broken. Laminated, tempered glass is available when both lamination and tempering are desired. Heavy wind-load areas or hurricane regions may use laminated glass in fenestration products to keep the glass intact after impact, helping to maintain a sealed building envelope. When using laminated glass in cold

climates, the laminated glass should be placed to the interior or warm side of the fenestration product for optimal performance. Test criteria from ASTM E90, Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements,¹ give 68°F to 75.2°F as the allowable temperature range to conduct sound transmission class testing. At this range, the PVB interlayer stays supple and provides the optimal sound attenuation performance. However, at lower ambient temperatures, the interlayer becomes stiff, significantly limiting its sound dampening capabilities.

9.2 Product Performance

Understanding the performance requirements that industries use for manufacturing architectural products is critical. In order to write specifications for biddable construction documents in the public arena, federal acquisition standards require that projects provide multiple options for products to secure a competitive bid. To compare products and determine their equivalency, designers and manufacturers use performance standards.

9.2.1 Performance Testing: Air, Water, and Structural

Performance testing should be completed by an independent certified lab in accordance with AAMA/WDMA/CSA 101/I.S.2/A440, North American Fenestration Standard (NAFS), Standard Specification for Windows, Doors and Unit Skylights. This test procedure will include design pressure testing, air infiltration, water resistance, structural load testing, and forced entry compliance testing. All products should be tested to the gateway size² indicated by the performance test standard. Based on the geographic location of the SIP, additional testing and product certification may be required. High-velocity hurricane zones (HVHZs) will require additional impact and structural load testing and may require a production quality assurance program administered and reviewed by an approved independent third-party administrator. Windows fabricated with a primary and secondary sash assembled as a dual window must be tested and certified in compliance with the dual-window (DW) test criteria.³ Performance tests must be updated every 4 years since the tests expire 4 years after the initial test completion date.

In the 1997 and 2002 editions, there were five performance classes for windows, described as R for residential, LC for light commercial, C for commercial, HC for heavy commercial, and AW for architectural. The descriptions were intended to act as a general guide in helping to determine which class was best suited for a particular application.

For the 2008 edition of NAFS, the C and HC performance classifications have been eliminated. A new CW classification has been added, which reduces the total number of performance classifications to four. Entry-level (gateway) performance grades are:

- 15 lbs/ft² (720 Pa) for R class (commonly used in one- and two-family dwellings),
- 25 lbs/ft² (1200 Pa) for LC class (commonly used for low- and mid-rise multifamily dwellings and other buildings where larger sizes and higher loading requirements are expected),
- 30 lbs/ft² (1,440 Pa) for the new CW class (commonly used in low- and mid-rise buildings where larger sizes, higher loading requirements, limits on deflection, and heavier use are expected), and

¹ ASTM International, ASTM E90, Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.

² Each AAMA window performance class requires that the window sample submitted for testing be a minimum defined size that is different for each class.

³ AAMA/WDMA/CSA101/I.S.2/A440, Dual Window (DW) Test Standard.

- 40 lbs/ft² (1,920 Pa) for the AW class (commonly used in high-rise and mid-rise buildings to meet increased loading requirements and limits on deflection, and in buildings where frequent and extreme use of the fenestration products is expected).⁴

9.2.2 Acoustical Performance

Acoustical performance testing should be completed by a lab certified by NVLAP and in conformance with ASTM E90 test procedures. STC values should be obtained by applying the TL values to the STC contour of ASTM E413, Determination of Sound Transmission Class. OITC performance testing should follow ASTM E1332 standards, and the transmission loss data used to determine the *A*-weighted sound level reduction. All fenestration products must be fully assembled, operational, and tested as a complete unit. Component part testing, such as only glass or only door slab components, is not permitted. Currently, acoustical tests do not have an expiration date. In that regard, it is important for specifications used in SIPs to establish retesting or updated testing criteria. As a baseline, retesting or updated testing should occur at a minimum of every 10 years and whenever a manufacturer makes changes to the product.


9.2.3 Test Data: STC Versus OITC

Sound transmission through a window or door is measured in an acoustical laboratory made up of two reverberation chambers. The rooms are divided by a separation wall designed to eliminate sound transfer between the two rooms or chambers. An opening is prepared in the separation wall, and the window or door is installed into the opening. When completely installed, the only sound that can travel from one chamber to the other is the sound that passes through the installed test sample. A sound source, placed in one of the reverberation chambers, injects high-level broadband noise into the chamber. Sound pressure levels are measured in both chambers simultaneously. The measured difference in the sound pressure levels between the chambers is calculated as the sound TL and is expressed in decibels. During the test, the TL values are measured in frequency bands between 80 Hz to 4000 Hz. These values are then used to calculate a single-number rating for the performance of the window or door assembly.

Two single-number rating systems are available to measure TL values. The first and most widely used is the STC rating. STC was originally designed to measure the performance of interior partition walls, but its use has been expanded to cover virtually all types of products used to separate noise events. The STC rating is a single-number rating generated from 16 TL values between 125 Hz and 4000 Hz. The STC curve is designed to correlate with sound associated with human speech. The second single-number rating system is the OITC. The OITC has a different frequency range than the STC rating and places more significance on low-frequency sound, which relates more closely to aircraft noise. The OITC rating is the *A*-weighted sound level difference between exterior traffic noise and the resulting interior noise. The definition of *A-weighted sound level*, in simple terms, is the standard measure of the sound pressure level that approximates the sensitivity of the human ear at moderate sound levels. Therefore, the *A*-weighted sound level places less emphasis on high and low frequencies because the human ear poorly perceives these noise levels. Consequently, the OITC sound metric has a different frequency range and weighting than the STC rating, with a greater emphasis on lower-frequency sound.

This is important because the STC rating is the most common metric used by manufacturers to rate the noise-reducing performance of their products. However, products that have a higher STC rating may perform marginally at some important lower frequencies. There may also be

⁴ Performance Class Overview, American Architectural Manufacturers Association, accessed January 2012, <http://www.aamanet.org/general/1/407/performance-class-overview>.

 <div> World's Best Window Co. Millennium 2000+ Vinyl-Clad Wood Frame Double Glazing • Argon Fill • Low E Product Type: Vertical Slider </div>	
ENERGY PERFORMANCE RATINGS	
U-Factor (U.S./I-P)	Solar Heat Gain Coefficient
0.35	0.32
ADDITIONAL PERFORMANCE RATINGS	
Visible Transmittance	Air Leakage (U.S./I-P)
0.51	0.2
Condensation Resistance	
51	—
<small>Manufacturers stipulates that these ratings conform to applicable NFRC procedures for determining whole product performance. NFRC ratings are determined for a fixed set of environmental conditions and a specific product size. NFRC does not guarantee any product and does not warrant the suitability of any product for any specific use. Consult manufacturer's literature for other product performance information. ©2009 NFRC.</small>	

Courtesy NFRC.

Figure 9.3. NFRC product label.

instances where a product performs better at lower frequencies, reflecting a better OITC value, but has a lower STC performance rating. When reviewing sound performance data, it is important to review the TL values to establish at what frequencies the product is providing its best sound attenuating performance.

9.2.4 Thermal Performance

Thermal performance is becoming an increasingly important issue within SIPs because many cities and municipalities have adopted new or updated energy standards within their building code requirements. Energy codes vary substantially by geographic region and must be reviewed by region to establish code compliance criteria. It is important to review the thermal performance requirements on a routine basis to ensure compliance with routinely changing codes. All fenestration products must be independently tested for thermal performance and compliance. Thermal performance testing should be conducted in compliance with current NFRC or AAMA 1503 standards (see Figure 9.3). Select a single test method so that all fenestration products of a given material type may be reviewed under the same test criteria.

It is important to note that the condensation resistance (CR) rating established by the NFRC test standard is **not** equivalent to the condensation resistance factor (CRF) as determined by the AAMA 1503 standard. As the Minnesota Sustainable Housing Initiative states:

The differences between the CR and CRF ratings are significant, though their goals are the same. The primary method of determining the CR rating is through simulation, while the CRF is based on measured data. Both should be used primarily as comparative evaluations between windows. Since there is no current data available to compare CR and CRF ratings, determining whether a CRF rated window performs better than a CR rated window, or vice versa, is difficult.⁵

Thermal performance tests must be updated every 4 years since the tests expire 4 years after the initial test completion date.

⁵ Information Brief – Condensation Resistance, Window, Minnesota Sustainable Housing Initiative, accessed January 2012, www.mnshi.umn.edu/kb/scale/condensationresistance.html.

9.3 Product Durability

Product durability refers to the quality and life expectancy of fenestration products used in SIPs. Specifying long-lasting and consistently functioning products is an important part of the product procurement process. Most programs want to provide participants with long-term product warranties that can only be secured for good quality products. The commitment of the manufacturer to its sound insulation products and the length of time it has been in business may be quality factors to consider as well when choosing products to specify.

Review of the longevity and reliability of the window and door products can be accomplished through the component parts, such as weather stripping, hardware, sash balance systems, base material, joint construction, and glazing materials, all of which should be evaluated for their long-term performance and the ability of the building owner or homeowner to reasonably acquire and replace them. Many acoustical fenestration products use heavy sheet or laminated glazing materials; review should include heavyweight balances to support additional weight and structural loads placed on the product and the ability of the product to perform over time. Economic concerns of maintaining or replacing the glass and glazing components in the future should also be considered. Expensive glass used to achieve the noise reduction may be hard for homeowners to replace if broken.

9.3.1 ACRP Project 02-31, “Assessment of Sound Insulation Treatments”

At the time of the publication of these guidelines, the Airport Cooperative Research Program began ACRP Project 02-31, “Assessment of Sound Insulation Treatments,” to conduct research and provide evaluation of the performance of acoustical products and treatments in previous SIPs, including the proper maintenance required to ensure the longevity of the acoustical treatments provided. It is recommended that users of these guidelines review the results and recommendations of ACRP Project 02-31 for further information regarding sustainable and effective noise reduction products and treatment strategies.

9.3.2 Role of the Building Owner

As part of the product sustainability function, it is important for SIPs to properly define the role that the building owner plays in the proper maintenance, service, and care required to ensure product performance and longevity. Most manufacturers provide care and maintenance manuals designed to inform building owners on how to properly care for the acoustical products they receive. Failure to properly maintain these products will generally reduce the products’ useful lives and may void the manufacturer’s warranty. Once the contractor’s warranty has elapsed, building owners will be communicating with manufacturers for extended warranty service.

9.4 Specifications of Acoustical Products

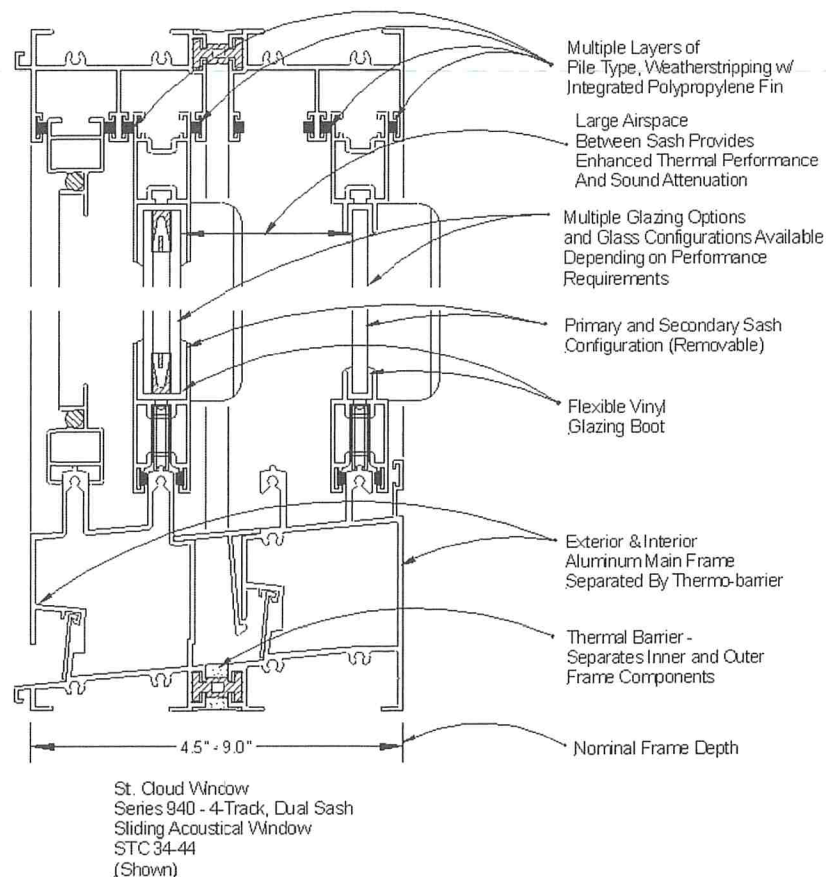
9.4.1 Replacement Windows

Acoustical window systems are manufactured with a variety of assembly methods and materials providing a wide range of STC performance results. However, no matter which system a program uses, the final performance of the product depends greatly on careful installation. Most acoustical windows are built with close tolerances and require extra effort during installation to ensure that noise does not enter the building by flanking the window

unit. Also the units must be square to ensure that the designed seals and gaskets perform. Properly preparing the opening to receive the acoustical window is a critical step in the process to ensure the performance of the acoustical treatment. Acoustical windows are designed in several different ways.

A. Aluminum Acoustical Dual Window

The aluminum four-track acoustical window system is available in double-hung, slider, and fixed-lite configurations. Overall frame depths vary from 4½ in. to over 9 in. The main frame is in two sections joined by a non-heat-conducting thermal barrier system creating a frame that can provide an inner and outer window (see Figure 9.4). Several thermal barrier systems are available and vary by manufacturer. They include extruded PVC, glass-reinforced nylon or polyamide, and poured and de-bridged polyurethane. The thermal barrier creates an inner and outer frame, which enhances the overall thermal performance and sound attenuation of the product since the energy of heat, cold, and sound waves is diminished from outside to inside. The dual-sash system consists of two primary and two secondary sashes. Both sets of sashes are removable to the interior for cleaning and maintenance. The four-track system allows for large air spaces between the primary and secondary sashes, enhancing STC performance. Sashes are dual weather stripped and designed with interlocking meeting rails. Several glazing options are available based on performance criteria. Primary and secondary sashes can be single glazed with monolithic glass to optimize the air space between sashes. Insulated glass can be supplied in the primary sash to increase thermal performance. The glass is marine glazed into the sash



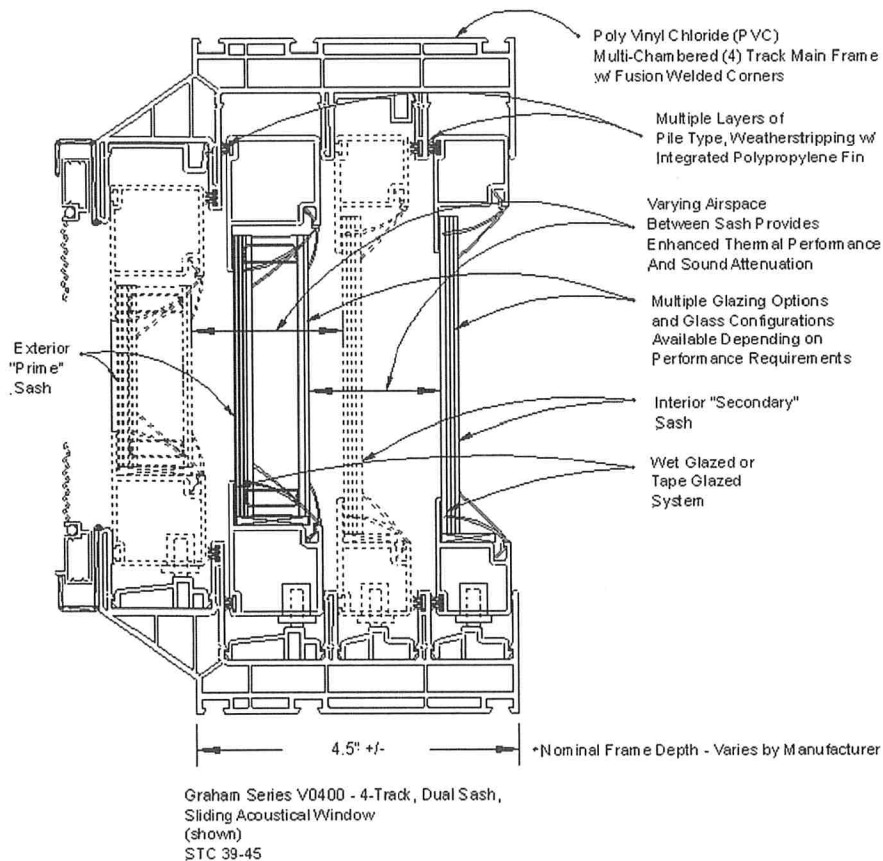
Courtesy of St. Cloud Window.

Figure 9.4. Aluminum 4-track acoustical window.

with a flexible vinyl glazing boot. The glazing boot cushions the glass, which helps to dampen sound transmission around the glazing pocket. STC performance ratings range from STC 40 to STC 55+ based on glass configuration and overall frame depth. Thermal performance varies greatly and must be reviewed by the manufacturer. AAMA performance ratings include LC, CW, and AW performance classes, depending on manufacturer and product series. Several painted finishes are available, including organic coatings and polyvinylidene fluoride organic finishes. Options for anodized finishes are also available.

B. Vinyl Acoustical Dual Window

This four-track acoustical window system is similar in design to its aluminum counterpart (see Figure 9.5). The main frame and sash are assembled from extruded vinyl or PVC profiles. PVC profiles are fabricated with impact-resistant plasticizers and titanium dioxide UV inhibitors for durability. The vinyl frame and sash profiles are multichambered for added thermal and sound dampening performance. Vinyl is not an efficient conductor of thermal energy and does not require a thermally broken frame. Frames and sash corners are fusion welded for strength and durability. Aluminum reinforcements may be placed in critical profiles to provide additional stiffness. Most manufacturers offer double-hung, slider, and fixed-lite configurations. Nominal depth of the main frame is approximately 4½ in. Primary sashes can receive a variety of glazing packages, from single-glazed (monolithic or laminated glass) to sealed insulated glass units made up of varying glass thicknesses. Secondary interior sashes are single glazed and can receive various thicknesses of monolithic or laminated



Courtesy of Graham Architectural Windows.

Figure 9.5. Vinyl 4-track acoustical window.

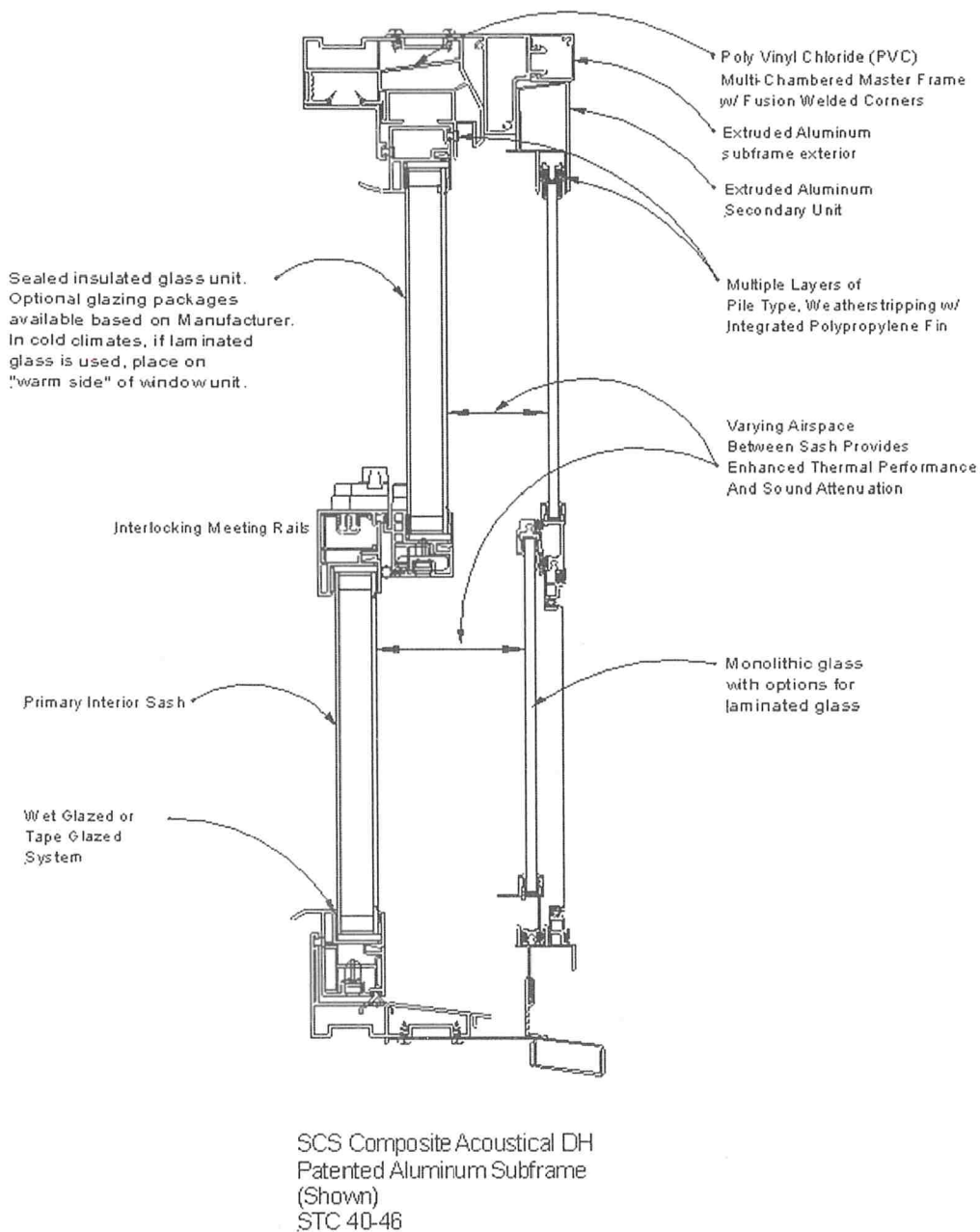
glass as required. Both primary and secondary sashes are removable to the interior, with some manufacturers offering double-hung windows with counterbalanced tilt-in sash features for ease of cleaning. Glass is generally wet glazed with silicone, or tape glazed into the vinyl sash. Both glazing systems cushion the glass, providing additional sound dampening effects. Sashes and frames are dual weather stripped with a pile-type weather stripping and integrated polypropylene fin. STC performance ranges from STC 39 to STC 45, depending on glazing configuration and window type. Thermal performance varies and must be reviewed by the manufacturer. *U*-values range from 0.47 to 0.21, and NFRC CR values range from 60 to 87, depending on glazing and window type. AAMA performance designations include LC and CW, based on manufacturer. The finish or color is impregnated throughout the material, making it extremely scratch resistant.

C. Composite Acoustical Dual Window

Composite acoustical windows combine various window systems and materials into a composite acoustical window assembly (see Figure 9.6). This type of assembly offers a variety of aesthetic and performance attributes that vary by manufacturer, with some manufacturers holding patents on their assembly systems. As with the other systems mentioned, double-hung, sliders, and fixed-lite configurations are available. Frame depth of the main frame varies from 3½ in. to 4½ in. Main frames are multichambered PVC with fusion welded corners. Some manufacturers offer an extruded aluminum sub-frame that, when combined with the vinyl mainframe, provides additional STC performance. The primary sash of the composite system is placed to the interior of the window system and is made up of extruded PVC with aluminum reinforcement of critical areas. The sash is glazed with a sealed insulated glass unit which can be made up of various glass thicknesses, (including laminated glass options). Energy films and gas-filled air spaces are available to improve the windows thermal performance. The secondary exterior window system is single glazed and can receive varying glass thicknesses of up to ¼-in. thick. This secondary window system is made from extruded aluminum profiles and is “marine” glazed with a flexible vinyl glazing boot for additional sound dampening performance. Primary and secondary sash are removable to the interior, with the prime sash of the double-hung windows provided with a tilt-in feature for ease of cleaning and maintenance. STC performance ranges from STC 40 to STC 46 depending on the glazing configuration. Thermal performance varies by manufacturers. *U*-values range from 0.33 to 0.19, with CR values from 68 to 80 depending on glazing and window type. AAMA performance designations include R, LC, and CW ratings depending on manufacturer and product series. All dual-window composite systems must be certified under the AAMA DW standard. Dual finishes are available, with interior finishes of integrated colored PVC, optional wood grain finishes, exterior finishes including organic (painted) finishes, and optional anodized finishes.

D. Wood Prime Window with Applied Secondary Storm Window Unit

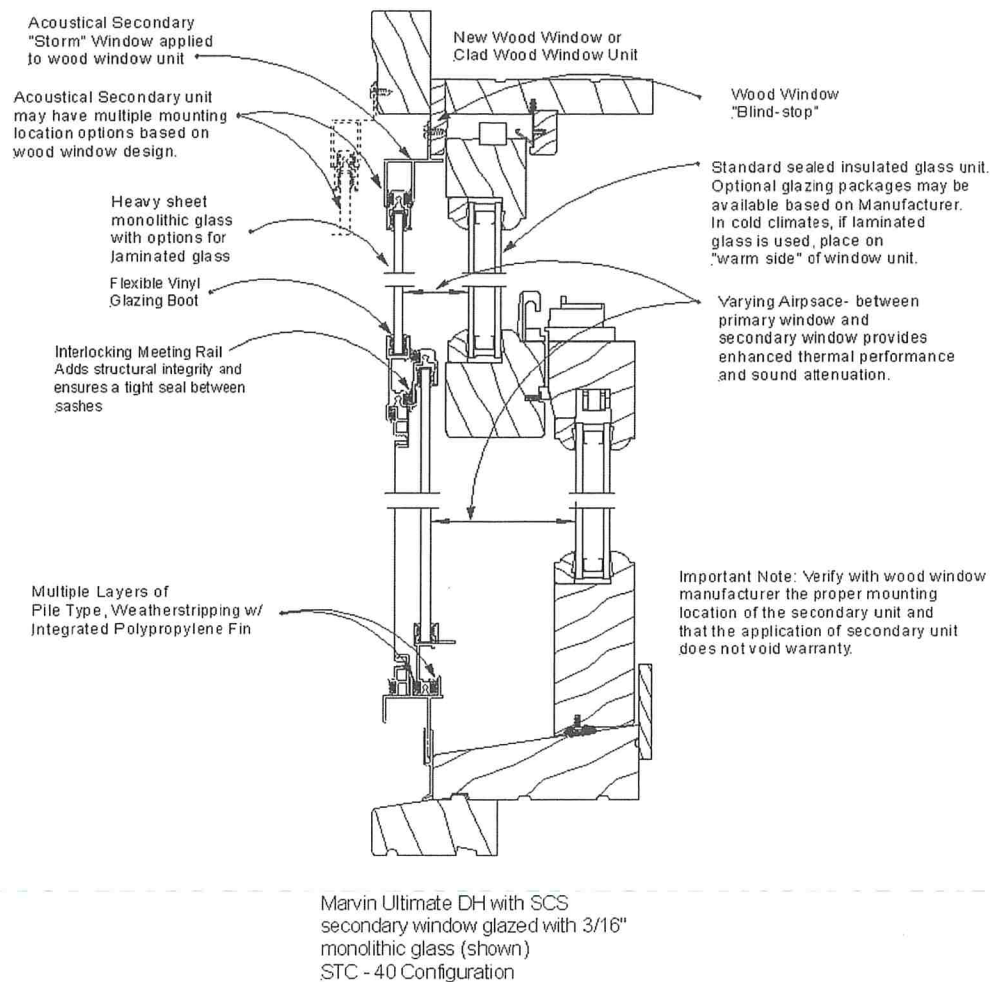
Wood prime windows with applied secondary or storm windows offer an acoustical treatment solution to programs located in wood window markets (see Figure 9.7). This system allows for the contractor to remove all existing dry-rotted and deteriorated wood components back to the rough opening. It can also be beneficial when wood windows with lead-based paint issues are prevalent. This type of configuration has also been used in the treatment of historic structures in certain geographic regions. Many programs specify a wood window manufacturer, along with an acoustical secondary or storm window manufacturer. It is important to verify the proper mounting procedures of the secondary unit with the prime wood window manufacturer to ensure that the application does not void the product warranty. There are a few acoustical window manufacturers that currently produce the wood prime window and acoustical secondary window as a factory-assembled unit. The secondary unit should be mounted to the blind stop of the wood prime window to ensure proper sealing and



Courtesy of SCS/Larson.

Figure 9.6. Composite vinyl/aluminum acoustical window.

weatherability. Caution should be used when mounting secondary units to the face of the wood window exterior trim, ensuring the secondary window is properly flashed to eliminate the possibility of a leak between the two units. Additionally, when attempting to mount the secondary unit to the exterior face of the wood window, it is important to verify that the sash of the secondary storm window can be removed through the prime window to the interior for cleaning and maintenance. STC performance of a conventional wood window, glazed with $\frac{3}{4}$ -in. sealed insulated glass, is STC 25 to STC 29, depending on glazing configuration and window type. Performance of the conventional wood window with an acoustical secondary storm window applied is STC 40 to STC 44. Independent structural and thermal testing should be conducted for the complete assembly.

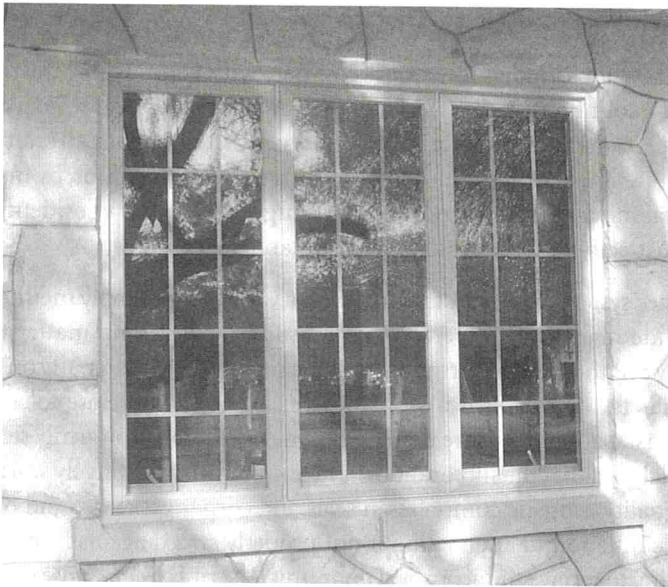


Courtesy of SCS/Larson.

Figure 9.7. Acoustical secondary storm window over wood window unit.

E. Acoustical Casement and Projected Units

Acoustically rated casement and projected window products are available in aluminum, vinyl, and composite window systems (see Figure 9.8). Although these windows are fabricated from various base materials, these products have similar designs and glazing configurations. Acoustical casement and projected windows tend to use compression-type weather stripping of closed-cell urethane foam enclosed in a polyurethane cladding. This weather stripping provides a substantial, positive seal around the sash perimeter. This results in extremely low air infiltration and increased sound attenuating performance. Although glazing packages vary by manufacturer, there are only a few glazing options available. One option is to glaze the unit with a 1-in. overall sealed insulated glass unit made up of two sheets of $\frac{1}{4}$ -in. laminated glass and $\frac{1}{2}$ -in. air space. The other glazing option includes a sealed insulated glass unit, usually made up of two sheets of annealed glass, with a secondary acoustical glazing panel, either applied to the operating sash or installed into the screen track of the window frame. Acoustical panels installed into the screen track will require the owner or tenant to remove the acoustical secondary glazing panel for ventilation or egress. STC performance ranges from STC 34 to STC 42, depending on glazing configuration. Thermal performance varies greatly by manufacturer and fabrication materials, and must be reviewed per product for code compliance. AAMA performance des-



Courtesy of SCS/Larson.

Figure 9.8. Acoustical casement unit.

ignations include R, LC, C, HC, and AW ratings for products. Overall frame depths vary from 2½ in. to 3¾ in., depending on the product and manufacturer. Since projecting windows do not routinely open to 90 degrees, when used in emergency egress locations, they need to be specified with special extension arms. Varying hinge treatments are also available when surface-mounted or hidden hinges are desired.

9.4.2 Acoustical Sliding Glass Doors

Acoustical sliding glass doors are available as a single or solo prime door unit or configured with an additional secondary or storm door unit applied.

A. Acoustically Rated Sliding Glass Doors

Acoustical prime patio doors are available in aluminum, vinyl, and wood frame materials. All single door units are glazed with sealed insulated glass assembled with laminated glass or heavy sheet tempered glass. STC performance results range from STC 35 to STC 38, depending on the door configuration, glazing options, and glazing air space. This system allows for the use of high-performance coatings, gas-filled air spaces, and tinted glazing options to enhance thermal performance. Some manufactures also offer high-performance acoustical sliding door systems that meet impact and HVHZ test requirements.

B. Tandem Sliding Glass Door Assemblies

Tandem acoustical sliding glass doors are also available from various manufactures. Tandem sliding glass doors refer to the additional application of a sliding secondary or storm door to the patio door system. Tandem door systems reach STC performance results of up to STC 47 and provide a substantial increase in overall thermal performance over the single door system. This tandem door system is most generally accepted in cold climate regions where the application of secondary or storm door products is a generally accepted practice. Warmer regions may not accept the aesthetic appearance of such a door, and those in warmer regions may gravitate toward the single door system.

9.4.3 Replacement Swinging Doors

As referenced in previous guidelines, “doors compete with windows for the role of the weakest link in the dwelling’s sound insulation performance. Almost all typical residential doors require modification or replacement to provide the necessary protection from aircraft noise.”⁶ Acoustically treating door openings can be achieved by treating the existing door, by installing an acoustically rated stand-alone door system, or by combining a high-quality residential entrance door system and an acoustically rated secondary door in tandem.

Acoustical entrance systems are manufactured with a variety of assembly methods and core materials providing a wide range of STC performance results. However, no matter which entry door system is used in any SIP, the final performance of the assembly depends greatly on the correct installation of these products. Most acoustical door systems are built with close tolerances and require extra effort during installation to ensure that the perimeter seals are uniformly seated along the full length of the door slab and that the sill condition and bottom sweep positively seal across the bottom of the unit. High-quality acoustic compression seals and corner gaskets found on acoustical door systems will provide little sound attenuation if not properly seated against the door slab. Properly preparing the opening to receive the acoustical door unit is a critical step in the process to ensure the performance of the acoustical door treatment.

A. Treating Existing Doors

Modifying the existing door can achieve sound deadening results if the existing door has adequate mass (greater than 8 lbs/ft²),⁷ is structurally sound, and fits squarely into the existing frame. If all these conditions exist, replacing the weather stripping of the existing door with heavy acoustical seals and applying a positive sealing bottom sweep and treating any sidelights may provide adequate sound attenuating performance. All penetrations through the existing doors, such as mail slots, must also be adequately blocked and sealed. If the existing doors do not fit properly or do not have adequate mass, the doors should be replaced.

B. Acoustically Rated Entrance Doors

Acoustically rated entrance doors, offered with galvanized steel, wood, and composite wood veneer, are a popular option currently used in many SIP’s exterior skins. As referenced in the 2005 guidelines,⁸ typical performance ratings range from STC 29 to STC 43. Although these doors have a similar appearance to the aforementioned residential pre-hung door systems, the internal core of the door is significantly different. The wide range of STC performance implies various engineered core materials and fabrication techniques. However, the one main attribute consistent with all acoustically rated doors is the addition of significant amounts of mass. The weight of acoustically rated doors ranges from 7.4 lbs/ft² to 8.6 lbs/ft² (for STC 29 to STC 38 performance) to as much as 12 lbs/ft² to 14 lbs/ft² (for doors achieving results in the STC 42 to STC 44 range). The core of an acoustical entry door is made up of a series of solid wood or composite materials for doors achieving STC 29 to STC 31 performance. Layers of cross-banded engineered wood composites are added to increase STC performance to the mid-30 range. Additional layers of sound deadening materials, many of which are proprietary, are added to the core to achieve the optimum STC performance.

To support the considerable amount of weight, the rails of the door are assembled with structural composite lumber. Heavy-duty ball bearing hinges are required to carry the additional weight

⁶ See note 1.

⁷ Department of the Navy, Naval Facilities Engineering Command, *Guidelines for the Sound Insulation of Residences Exposed to Aircraft Operations*, as referenced in FAA Advisory Circular 150/5000-9A, April 2005.

⁸ Department of the Navy, Naval Facilities Engineering Command, *Guidelines for the Sound Insulation of Residences Exposed to Aircraft Operations*, as referenced in FAA Advisory Circular 150/5000-9A, April 2005.

associated with the acoustical door panels. Installation of these doors must include the inspection of the rough opening to ensure that the framing members are in solid condition. If the framing members show signs of decay or are not adequate to support the acoustical door, the opening must be modified prior to installation. Installation screws should be placed through each hinge leaf and should be of sufficient length to penetrate a minimum of 1½ in. into the framing members. Perimeter seals and corner gaskets should include replaceable compression-type weather stripping made up of closed-cell urethane foam enclosed in a polyurethane cladding. Door sills should include an extruded aluminum exterior with an adjustable riser to ensure adjustability and proper fit in the field. Some manufacturers provide a spring-loaded retractable door sweep that seals against the sill when the door is closed. Out-swing doors should include a bumper sill configuration with a compression-type weather seal that seals against the surface of the door slab when closed.

C. Tandem Entrance Door Assemblies

The application of high-quality insulated steel and wood residential entrance doors, in combination with an acoustical secondary storm door, is an economical and aesthetically popular SIP acoustical treatment strategy (see Figure 9.9). The value of this application is the conventional appearance and availability of the products used. This product combination is energy efficient and provides solid STC performance values.

Insulated steel entrance doors with a typical 24-gauge steel skin and polyurethane steel core weigh in at approximately 5.2 lbs/ft² to 5.8 lbs/ft² and provide an STC performance rating of STC 22 to STC 27. The addition of an acoustical secondary or storm door with a minimum performance rating of STC 30 brings the values of the system to STC 40 to STC 42.



Courtesy of SCS/Larson.

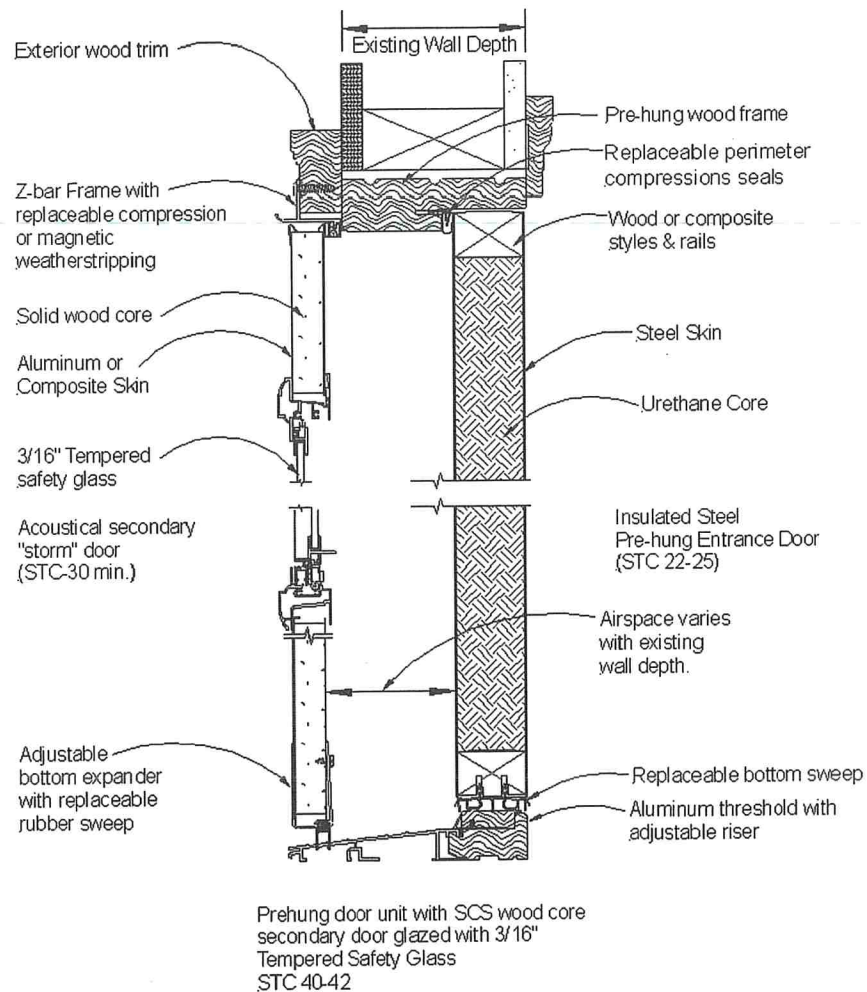
Figure 9.9. Steel entry door with acoustical secondary.

Several door manufacturers offer optional core materials in lieu of the polyurethane core to enhance performance. Solid wood block or engineered particleboard cores increase the weight of the door to approximately 7.0 lbs/ft² to 7.5 lbs/ft² and provide STC results of STC 27 to STC 29. Wood-veneered skins can be applied to the solid core materials when a solid core wood door is preferred. The application of an acoustical secondary or storm door increases the performance of the combined system to STC 42 to STC 44.

The air space created between the primary door and the secondary door will vary by product manufacturer and overall wall depth of the structure (see Figure 9.10). Varying air spaces between the primary and secondary door systems will affect the overall STC performance of the assembly. STC testing should be conducted on the complete assembly consisting of both the primary and secondary door to ensure that the overall STC performance is acceptable. The application of this type of door system should be reviewed by geographic region to ensure performance compatibility and homeowner acceptance.

D. Door STC Tests

Most entrance door systems are assembled from a variety of component parts supplied by several different manufacturers. The door distributor or the contractor in the field generally



Courtesy of SCS/Larson.

Figure 9.10. Insulated steel pre-hung entry door with acoustical secondary storm door.

assembles these component parts into a finished or pre-hung door system. STC tests provided by an independent certified lab should include the entire door assembly, pre-hung in the frame and completely operational. It is important that the test list the component parts used in the test door assembly to ensure that the doors fabricated for the project match the test door specimen. STC tests conducted only on door slabs should not be accepted because they do not represent the performance of the complete door assembly, including the perimeter seals and threshold. If an acoustical door slab is installed in an existing frame, jamb weather stripping, sill sweeps, and sill conditions should closely match those components outlined in an independent certified test report to ensure that the component parts used closely match the tested assembly.

9.4.4 High-Velocity Hurricane Zones and Impact-Rated Acoustical Products

SIPs operating in HVHZ zones face unique product design and approval issues associated with sound insulating structures within these areas. Currently, few manufacturers produce acoustical window and door products for use in these regions. However, the few that have committed to the manufacturing of these specialized products have invested heavily in the design of their products and the required product approval process. As an example, programs located in southern Florida are located in a designated HVHZ.

A. HVHZ Product Testing and Certification

The state of Florida requires a stringent testing and certification process for all window and door products installed in HVHZs. Mandatory testing protocols include three major test criteria, TAS (Testing Application Standard) 201, 202, and 203, with all testing conducted by an independent certified laboratory (see Figure 9.11).

TAS 201 – Large Missile Impact Test. TAS 201 is the test protocol that covers procedures for conducting large missile impact testing. Large missile impact testing consists of impacting three various locations of the window or door assembly with wood traveling at a speed of 50 ft/s (34 mph).

TAS 202 – Uniform Static Load Test. This test measures air infiltration, water penetration, and structural loading of the window or door assembly. During this test procedure, the test specimen is subjected to severe test pressures (in some cases, in excess of ± 100 lbs/ft²) to ensure the structural integrity of the assembly.

TAS 203 – Cyclic Load Test. Once the TAS 201 Large Missile Impact Test is successfully completed, the test specimen is then subjected to alternating positive and negative test pressures, similar to hurricane conditions, for a combined duration of 9000 cycles, under test standard TAS 203.

Although the glazing material can crack during these tests, no structural failure of the unit is allowed during the test procedures.

Upon successful completion of the testing protocol, all assembly methods, component parts, and installation details must be cataloged and submitted to an independent professional engineer registered in the state of Florida for a complete product review and evaluation. Once the review is complete, the independent engineer certifies the evaluation and submits the information to the Florida Department of Business and Professional Regulation to receive final product approval. The final documents are reviewed by the Florida Building Code (FBC) department for final approval. Once approved, the FBC issues a Florida products serial number uniquely identifying the approved product and registers the product on the FBC website. Manufacturers producing approved products are also required to participate in a state-approved, independently administered quality assurance program. This program requires independent and unannounced inspections of the manufacturing facilities producing certified products to ensure that



Courtesy of SCS/Larson.

Figure 9.11. Successful completion of TAS 201 – Large Missile Impact Test and TAS 203 – Cyclic Load Test.

the fabrication and assembly techniques of the window or door products produced match the product information certified and registered with the state of Florida.

The installation of approved products in Florida SIPs requires a building official's inspection of the product, installation technique, and fasteners prior to the application of any type of finish trim materials. All approved products must be factory labeled with their assigned Florida product serial number. The building inspector will review the reference materials outlining the product and installation instructions and verify that the conditions listed on the documents match the product and installation. Any deviation from the approved information will be cause for the product to be rejected.

B. HVHZ Window Products

Because of the design loads and performance requirements associated with acoustical windows fabricated for these regions, products use multiple layers of heavy sheet glass with the interior glazing material made up of heavy sheet laminated glass with a 0.090 PVB interlayer. Products are available in both extruded aluminum and reinforced PVC frame and sash profiles. Current window systems incorporate a dual-window design containing a primary and secondary sash system to enhance sound attenuation. STC performance ranges from STC 44 to STC 47.

C. HVHZ Door Products

Impact- and acoustically rated sliding glass patio door systems are also available for use in HVHZs. Although there are currently a limited number of manufacturers to choose from, these doors are manufactured as a single or solo prime door unit with STC values of approximately STC 38. These doors are glazed with multiple layers of laminated glass and sealed into a stout insulated glass unit, with the interior laminated glass using a 0.090 SGP interlayer. Frame materials currently available are heavy PVC-extruded profiles with aluminum reinforcement. Heavy-duty hardware and roller assemblies are incorporated to handle the substantial weight of the overall assembly. Impact-rated French doors in tandem with a sound-rated interior French or sliding door is another option to replace sliding glass doors.

Acoustically treating swinging door openings includes the application of a pre-hung entrance door in tandem with an impact-rated secondary door system. STC performance is enhanced by the air space created between the primary and secondary unit along with the additional mass and heavy sheet glazing material designed into the secondary impact-rated door system. There are stand-alone doors available to meet both the sound and impact requirements of the Florida programs, but they are limited in aesthetic options.

9.4.5 Additional Products Available

A. Acoustical Secondary Window and Door Systems

Secondary or storm windows and doors are an important acoustical treatment option for most SIPs across the country. Secondary acoustical window and door products provide an economical solution for the acoustical treatment of existing prime window and door openings. Specialty shapes such as arch tops and half-rounds can be fabricated as secondary units to acoustically treat unique prime window conditions. Secondary windows are manufactured to match the operation of the prime window unit. Double-hung, slider, and fixed-lite configurations are all available as secondary window units. Specialty acoustical panels are manufactured for use with prime casement, awning, and other projected window types. Secondary acoustical skylight panels are available to provide the acoustical treatment of existing skylights and other sloped glazed window systems (see Figure 9.12).

Most acoustical secondary windows are fabricated from aluminum extrusions and offer a variety of finishes and color options to complement the color scheme of the structure. Wood-framed acoustical secondary units are also available when matching the material of a prime wood window is critical. A variety of glass types can be glazed into the secondary window system. Obscure glass can be installed when additional privacy is required, and a variety of tinted glass options or glass with high-performance coatings can also be glazed into the secondary unit to enhance shading coefficients and thermal performance. STC results of acoustical secondary windows range from STC 29 to STC 33, based on window configuration and glazing type. Installing a secondary window to a prime window adds a considerable amount of additional mass and creates a substantial amount of air space between the primary and secondary unit, significantly enhancing the sound deadening performance of the complete window assembly. Historic structures use secondary units for acoustical treatment, enhancement of thermal performance, and to protect historic window components (such as leaded glass and custom wood-frame profiles) from exposure to the elements. Some SIPs providing acoustical treatments in regions where wood windows are predominant offer wood or clad wood prime windows with an acoustical secondary window as their acoustical treatment strategy. Pairing standard wood window assemblies with acoustical secondary units provides performance in the STC 40 to STC 44 range.

Acoustical secondary doors, or storm doors, are a popular SIP acoustical treatment strategy. Unique existing prime door styles such as arch-top doors or prime doors with distinctive features

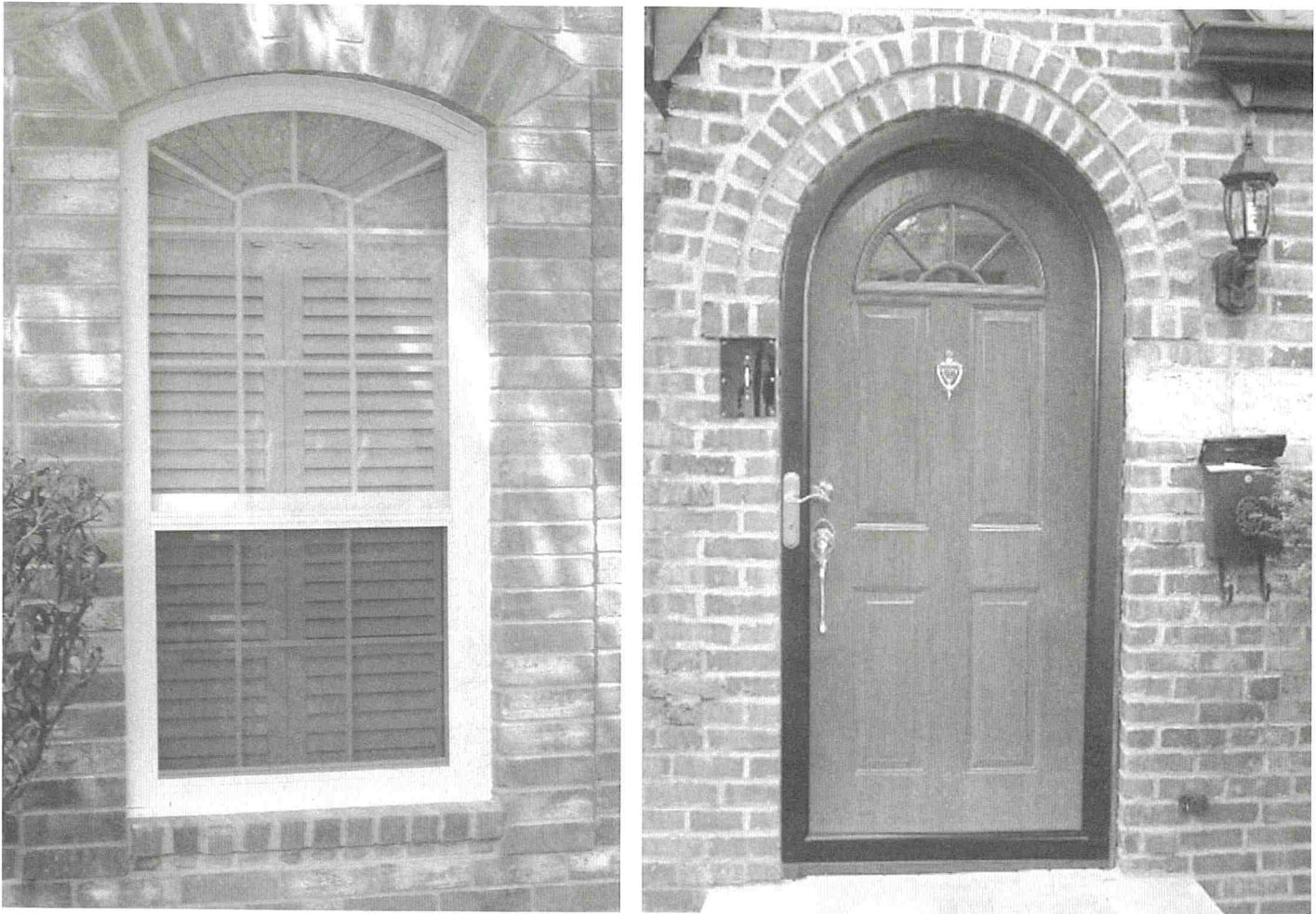


Courtesy of SCS/Larson.

Figure 9.12. Secondary skylight system.

such as leaded glass can be repaired, weather stripped, and acoustically treated with the application of a secondary door system (see Figure 9.13). As previously referenced, the application of secondary doors over conventional insulated steel or fiberglass replacement door systems is the most predominant use of a secondary door unit. Secondary doors are available in a multitude of styles, hardware finishes, and color options, providing SIPs multiple product choices. Secondary acoustical security doors are also available when needed to match an existing secondary security door that requires replacement, or when additional security is required. Many secondary door styles are available with screen options. Although when ventilating through the secondary door the sound attenuating performance of the door is negated, there will be instances in which the owner prefers the ventilation. STC performance of secondary doors ranges from STC 29 to STC 33, depending on door style and glazing. STC 40 to STC 44 performance is achieved when installed in combination with an insulated steel or fiberglass replacement door system.

When the decision is made not to replace the existing patio door with an acoustically rated prime patio door unit, the addition of a secondary patio door installed over the existing door or standard replacement door system may be the appropriate treatment option (see Figure 9.14). In markets where wood sliding glass doors are prominent, acoustical secondary sliding glass doors are used to protect the prime door and acoustically treat the door opening. Most applications mount the sliding glass secondary door to the exterior face of the prime patio door frame. In many cases the exterior casing and sill condition of the existing door must be modified to accept



Courtesy of SCS/Larson.

Figure 9.13. Secondary window and secondary storm door.

the secondary door application. The sliding secondary door operates in the same manner as the prime sliding door and creates a multiple-panel, dual-door system. The application of a secondary patio door may not be an acceptable option in all markets. Programs located in warmer climates may receive strong resistance to the application of a secondary sliding glass door system. STC performance of secondary sliding patio door system ranges from STC 30 to STC 33, depending on door style and glazing.

9.5 Product Manufacturer Requirements

9.5.1 Product Warranty

Products installed in SIPs should carry a minimum 10-year product warranty, with the start date being the date of final installation. The warranty must be non-prorated and transferable for the duration of the warranty period. During the 10-year period, the manufacturer is required to, at a minimum:

- Repair or furnish a new product, at no charge to the owner, for any manufacturing defects, excluding glass breakage or screen damage;



Courtesy of SCS/Larson.

Figure 9.14. Secondary sliding patio door.

- Warrant the structural integrity of the product, covering sagging or deflection under normal conditions;
- Warrant that equivalent replacement parts will be available for the duration of the warranty period; and
- Provide a finish warranty, covering blistering, crazing, or peeling of the factory-applied finish.

The insulated glass portions of the window and door products must also be warranted to not fail during the 10-year warranty period. A failed insulated glass unit is one that develops a significant obstruction of vision resulting from moisture formation or dust collection between the sealed insulated glass panes, which is caused by failure of the seal. The laminated glass material should also be warranted to cover edge separation of the glass and laminate, any delamination that obstructs the vision through the glass, and any blemishes that exceed those allowed by industry standards.

During the warranty period, the manufacturer or supplier must provide customer service support to address warranty issues, supply replacement parts, and provide technical assistance to owners.

9.5.2 The Buy American Act

The Buy American Act was implemented in 1933 to establish a preference for American-manufactured goods used in government-funded projects. This statute provides a definition

of what are and qualify as American-made goods, along with the proper reporting of their procurement and use. The statute also outlines requirements and guidelines when requesting waivers for using materials not made in America.

SIPs that receive AIP funding are required to follow the Buy American Act. Direction for the proper implementation of the Buy American Act can be found in the FAA's PGL 10-02, Guidance for Buy American on Airport Improvement Program (AIP) or American Recovery and Reinvestment Act (ARRA) Projects. The guidance letter states: "In accepting AIP or ARRA funding, grant recipients are certifying that they will not acquire (or permit any contractor or subcontractor) to use any steel or manufactured products produced outside the United States on any portion of the project for which funds are provided, unless otherwise approved by the FAA."⁹ It further states: "The AIP funded portion of a project includes the grant recipient's local share." A copy of the guidance letter can be found in Appendix D.

9.6 Updated Manufacturer and Product Matrixes

Updated matrixes of door and window manufacturers and their products may be found in Appendix C. Matrixes offer available information about products offered, performance ratings, STC ranges, and historical applications.

9.7 Best Practice Recommendations: Acoustical Products

1. Before approving any acoustical window or door product for an SIP, conduct a thorough product review for performance and compliance with program requirements, including analysis of fabrication information, assembly materials, glazing configuration, and independent test reports from a certified lab.
2. Performance testing should be completed by an independent certified lab in accordance with AAMA/WDMA/CSA 101/I.S.2/A440, Standard Specification for Windows, Doors and Unit Skylights. Based on the geographic location of the SIP, additional testing and product certification may be required, such as in HVHZs. Windows fabricated with a primary and secondary sash assembled as a dual window must be tested and certified in compliance with the DW test criteria. Performance tests must be updated every 4 years since the tests expire 4 years after the initial test completion date.
3. Acoustical performance testing should be completed by a NVLAP-certified lab and in conformance with test procedures from ASTM E90, Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements. Since acoustical tests do not have an expiration date, SIPs should establish retesting or updated testing criteria. As a baseline, retesting or updated testing should occur at a minimum of every 10 years and whenever a manufacturer makes changes to the product.
4. When reviewing sound performance data, review the TL values to establish at what frequencies the product is providing its best sound attenuating performance.

⁹PGL 10-02, Guidance for Buy American on Airport Improvement (AIP) or American Recovery and Reinvestment Act (ARRA) Projects, issued by the FAA on February 24, 2010, p. 1.

5. Review the thermal performance requirements on a routine basis to ensure compliance with intermittent code changes. Select a single test method so that all fenestration products of a given material type may be reviewed under the same test criteria. Thermal performance tests must be updated every 4 years since the tests expire 4 years after the initial test completion date.
6. Review the results and recommendations of ACRP Project 02-31 for further information regarding sustainable and effective noise reduction products and treatment strategies.
7. Take measures to ensure that products are properly installed since the final performance of acoustical products depends greatly on correct installation, which includes properly preparing the opening to receive the acoustical unit.
8. STC tests provided by an independent certified lab should include the entire door assembly, pre-hung in the frame and completely operational. It is important that the test list the component parts used in the test door assembly to ensure that the doors fabricated for the project match the test door specimen. STC tests conducted only on door slabs should not be accepted because they do not represent the performance of the complete door assembly, including the perimeter seals and threshold.
9. Products installed in SIPs should carry a minimum 10-year product warranty, with the start date being the date of final installation. The warranty must be non-prorated and transferable for the duration of the warranty period.

Construction Contracting

The perceived success and reputation of an SIP depend heavily on the construction phase of the program since this is when the sponsor either fulfills or disappoints the expectations of the program's participants. This is also when the sponsor contractually transfers significant control of the program to the construction contractor. For this reason, it is imperative that sponsors select a construction delivery approach responsive to the program's needs while addressing the unique nature of sound insulation.

Sound insulation programs are unique in the sense that:

1. Public funds are expended for capital improvement of private property by a contractor with no direct contractual relationship to the property owner. The construction contractor acts as a third party, responsible for executing and delivering on agreements, understandings, and expectations established contractually between the sponsor and property owner.
2. Due to the magnitude of the work and limitations on available funds and delivery resources, sound insulation programs typically require many years to complete. Use of public funds often mandates using a competitive bidding process to select a construction contractor, with contracts awarded to the lowest responsible bidder(s). SIPs tasked with providing consistent and responsive improvements to private property by means of multiyear projects completed by a variety of contractors have a considerable challenge. This challenge is met by providing contractor orientation regarding the unique third-party relationship to the homeowner, establishing consistent interpretation of contract provisions, and integrating the contractor into the sponsor's program delivery approach.
3. Fast-paced residential SIPs demand skill sets and capabilities beyond those of the industry-standard construction contractor. For example, many residential contractors will have the construction trade skills to complete the residential renovation work but lack the significant administrative skills necessary to succeed on a government-funded project. Conversely, in many instances, contractors experienced in delivery of government-funded projects are not experienced with residential renovation work.
4. Rather than providing construction on a single property for a single client, SIP contracts typically include 25 to 100 properties, each with a different owner. As a result, a sound insulation project essentially consists of multiple mini-projects, each with its own completion schedule. The magnitude of properties and involved parties significantly increases the quantity of issues to be addressed to keep stakeholders satisfied.
5. Construction contracts are required to meet the requirements of PGL 12-09, which stresses that AIP-funded projects, including SIPs, "meet all federal procurement and contract requirements including the Buy American Preference requirements of Title 49 United States Code 50101."¹ These requirements are addressed further in PGL 10-02, Guidance for Buy American

¹U.S. DOT, FAA, PGL 12-09, August 17, 2012, Attachment A, §812 (c)(2), p. 1-5.

on Airport Improvement (AIP) or American Recovery and Reinvestment Act (ARRA) Projects, issued by the FAA on February 24, 2010. Contractors will need to work with the program sponsor to determine if waivers are in place or need to be filed for the project to move forward. Since the FAA has specific rules not included in the federal acquisition regulations, it is important to be familiar with the FAA documents governing Buy American regulations.

10.1 Construction Delivery Approaches

This section provides a brief description of standard delivery approaches used in the general construction industry, as well as those developed for publicly funded projects such as SIPs. These general approaches are widely recognized and supported by government agencies that contract for construction services as well as by professional organizations such as the American Institute of Architects, the National Society of Professional Engineers, the Design Build Institute, and the Construction Management Association of America.

The material outlined here is not intended to be a complete presentation of all available options, but rather a summary of the most common delivery methods for sound insulation. This will help stakeholders have a meaningful dialogue regarding the best construction delivery approach for their program. For each of these delivery approaches, there is an entire body of books, reference materials, and standards that have been developed for their implementation. These references are made available by public agencies and professional organizations. With the assistance of a design or construction professional, construction delivery approaches can be modified to create the system that best meets an SIP's unique needs in concert with the sponsor's contracting regulations.

10.1.1 Design-Bid-Build: Single Prime

This is the most common and traditional approach for delivery of publicly funded projects. With this approach, the sponsor employs design professionals to prepare contract bid documents and conducts a public bid to general contractors; general contractors then execute the construction phase of the project. Under this approach there is considerable reliance on contract documents to effectively establish performance requirements for the general contractor. The general contractor has significant control of means and methods for meeting the established performance requirements.

This approach is most commonly used since it places the burden of construction on a single entity, the general contractor, and minimizes the sponsor's involvement in project management. Since project performance is heavily dependent on the general contractor under this approach, some contractually required qualifications or a prequalification process is recommended.

10.1.2 Design-Bid-Build: Multiple Prime

This approach is very similar to design-bid-build single prime, with the exception that the sponsor divides the project into separate sections, as appropriate for the specific project, and issues a prime contract for each section. For sound insulation projects, this usually includes a general construction contract, mechanical contract, and electrical contract; however, there are no limitations as to how a project can be divided under this approach. The sponsor will either act as coordinator of the multiple primes or delegate this responsibility to someone else, typically the general construction contractor. This approach lends itself well to task order or indefinite-delivery-type contracts.

10.1.3 Design-Build

Design-build (DB) relies on a single entity, procured by the sponsor on a competitive basis, to provide both the design and construction services necessary for completion of a project. The DB

entity can be a single firm or a team of firms, with the DB entity selection accomplished by a qualifications-based selection or competitive proposal selection process with a guaranteed maximum price or cost-plus fixed fee. Cost-plus percentage contracts are not allowed as DB contracts.² FAA AC 150/5100-14D, Section 4-8.xxxvii, Alternative Delivery Methods, and FAA Order 5100.38C, Section 3, Alternative Delivery Methods, detail the FAA's requirements for implementing DB. The FAA requires that a DB approach be approved by the FAA prior to use and that project conditions must be evaluated to determine if the more traditional design-bid-build approach is more appropriate before undertaking an alternative delivery method.

Proponents of DB believe the benefits of this approach include single-source accountability, reduced project delivery times, lower cost, higher quality, and less litigation. The use of DB is relatively new to the FAA and residential sound insulation programs, and as such, little independent quantitative analysis and study have been accomplished or published regarding proven benefits.

10.1.4 Design-Bid-Build with Some Elements of Design-Build

This approach is the same as design-bid-build single prime or multi prime, with responsibility for select portions of the project's design delegated for the construction contractor(s). For SIPs, the DB elements typically involve the mechanical systems, electrical systems, and ventilation. This approach is often used on renovation projects in order to avoid the initial cost of detailed design, which in many cases must be altered during construction to address unforeseen conditions. Such alterations create a significant administrative task for the design team. Shifting the responsibility of final design to the construction contractor minimizes the need for design alterations and corresponding change orders.

Effective use of this approach requires DB bid documents and specifications to provide information regarding existing physical conditions, detailed installation and performance requirements, and instructions addressing the various types of structures to be encountered on the project. This allows contractors to properly estimate the DB element of the project and under certain conditions can minimize change orders. Pre-bid physical inspection of representative structures is encouraged.

10.1.5 Construction Management Not at Risk

This approach is similar to the design-bid-build single prime or multi prime approach, with the added feature of employing a construction manager. In most cases, the construction manager will integrate into the design team and be responsible for construction-related aspects of the project, including cost estimates, constructability reviews, phasing, construction controls, construction administration and oversight, and contractor procurement. The construction managers will either solicit construction bids on the sponsor's behalf or hold construction contracts themselves. Under this approach, the construction manager is not providing an established price for the project but rather managing the construction aspect of the project on the sponsor's behalf.

The construction management not at risk approach integrates a construction professional into the process, which is helpful to a program using more complex approaches such as selective DB, multiple prime, or task order contracts. Construction management not at risk can establish continuity and consistency on multiyear sound insulation programs, which use a multitude of construction contractors.

² U.S. DOT, FAA, AC 150/5100-14D, Architectural, Engineering, and Planning Consultant Services for Airport Grant Projects, September 30, 2005, §4.8 c.2.

10.1.6 Construction Management at Risk

This approach provides a fixed cost for the construction phase of a project by competitive procurement of a construction manager. This approach guarantees the sponsor a fixed cost for a project, while allowing the construction manager to competitively procure construction contractors and manage the construction phase of the project. This contracting method is better suited to new construction. Due to the level of difficulty and level of sophistication necessary to use this approach on publicly funded renovation projects, it has not been used in SIPs at the time of publication and will not be discussed in detail.

10.1.7 Task Order Contract

This approach has not been used in residential SIPs in a pure sense but bears mentioning because a variety of federal agencies use this approach when procuring contractors for renovation and maintenance contracts. Under this approach, contractors must qualify to participate on a task order contract for an established period of time or for a capped dollar amount. Once placed under contract, qualified contractors competitively bid on task orders as they are issued. This approach typically uses a process that grades contractors on performance as they complete work. Contractors must maintain a minimum performance grade or forfeit eligibility to participate. This process has been used by some agencies as a means of prequalifying contractors to use as a short list of bidders.

10.1.8 Single Parcel Approach

Rather than grouping homes into a single construction contract for public bid, the single parcel approach allows for individual homeowners to be involved in the selection of the contractors who will do the work on their homes. The single parcel approach prequalifies local installation contractors and then invites individual property owners to select a minimum of three contractors to submit a competitive bid for the work on their property. This allows contact between the contractor and homeowner prior to the construction contract being awarded and still meets the public funding requirement for competitive bidding. Formally arranged gatherings introduce property owners to prequalified installation contractors while giving property owners the opportunity to inspect product offerings and make product selections for their project. This approach facilitates homeowner participation, thus furthering a degree of ownership in the process. The lowest responsive bidder of the homeowner-selected contractors is awarded the work. Some projects allow the property owner to select from responsive bidders after bids are procured; the property owner may select any installation contractor from the responsive bidders; however, if the selected contractor is not the low bidder, the property owner pays the difference between the low bidder and their desired contractor.

An integrated single parcel approach is currently being used in one SIP. Under this approach, the sponsor procures a single professional entity to administer, design, and contract for construction of the SIP. This approach blends elements of DB and the integrated project management approach as briefly presented herein. The responsible professional service provider under this arrangement facilitates homeowner communication, prepares design documents, manages a competitive bid process, administers contract award, procures product, inventories product, and manages construction. This approach allows a single entity to act as both program manager and general contractor and could be applicable to a multiple parcel approach as well.

10.1.9 Integrated Project Management (IPM) Approach

IPM is an approach specifically developed for SIPs by a variety of nationally recognized sound insulation professional service providers. This approach places all elements necessary for delivery of an SIP, except the construction contractor, under a single entity typically referred to as

the program manager. Elements of this integration typically include public relations, acoustical consulting, participant administration, design, construction administration, and construction inspection. Under this approach, a sponsor has a single entity with accountability, namely the program manager, rather than procuring a host of professionals and being responsible for integrating their services. IPM uses many of the construction delivery approaches outlined in Section 10.1.

The IPM approach is an effective tool for integrating the many facets of sound insulation under a single umbrella, providing a level of continuity for all elements of delivery, including construction, across a multiyear program. As it relates to construction, this approach is intended to break down communication barriers, facilitate timely resolution of issues, and create feedback for continuous process improvement.

10.1.10 Unit Price Considerations

Unit price payment items for construction contracts have been used in whole or in part for delivery of SIPs under the various approaches indicated previously. Several large SIPs have relied entirely on unit price payment items for administration of their construction contracts. Under the unit price approach, sound insulation improvements, including architectural, mechanical, and electrical, are broken down into logical discrete unit price work and payment items. Contractors are paid according to the quantity of unit price items necessary to complete the work. Some SIPs use unit price forms of contracting for dealing with unforeseen construction conditions and work that may be difficult to define. The use of a unit pricing approach for these situations helps reduce administrative burdens associated with change order processing.

10.2 Delivery Approach Considerations

Several considerations should be evaluated and discussed before selecting a construction delivery approach for any given sound insulation program. Following are some of the major considerations.

10.2.1 Level of Expertise

Generally speaking, the more sophisticated the construction delivery system, the higher the level of construction expertise required to succeed. Most sponsors and design professionals are well versed in the use of the design–bid–build single prime approach and likely have in-house staff that can support this system. If more sophisticated approaches are used, the addition of sponsor or consultant staff with specialized expertise administering the contracts and processes of nontraditional construction models is highly recommended.

In general, more complex construction delivery systems, if properly implemented, can result in higher stakeholder satisfaction rates. However, due to the increased skill level necessary to implement sophisticated delivery approaches, they are also ripe for failure if the appropriate skill sets are not present on the sponsor's implementation team. This should not be taken as an impediment to exploring more sophisticated delivery approaches; simply acknowledge up front that striving to obtain higher stakeholder satisfaction rates involves developing a professional services team with the requisite experience to deliver on these approaches.

10.2.2 Internal Considerations

In many situations, a sponsor's existing internal procedures, standard forms, and agreements do not support a sophisticated construction delivery system or even a modest modification to

the traditional design–bid–build single prime approach. When considering a delivery approach for sound insulation, it is prudent to review the sponsor's existing procedures to determine what level of complexity the sponsor can currently support. Evaluate what changes the sponsor would be willing to consider in support of a more tailored construction delivery approach.

10.2.3 Public Relations and Accountability

The high number of individual properties contained in a residential SIP means a high number of stakeholders. Additionally, since public funds are involved, there is significant political influence and interest and thus a high level of accountability. Accordingly, the construction delivery approach needs to recognize this reality and provide well-defined, well-coordinated lines of communication to accommodate the many stakeholders, accomplish day-to-day project coordination, and resolve issues in a timely manner.

As previously presented, sound insulation programs garner significant public attention. During the construction phase of a program, when contractors must deliver on stakeholder's expectations of the process and finished product, public relations issues are heightened. Accordingly, construction delivery approaches must support timely resolution of issues that affect the participants' and public's perception of the program.

10.2.4 Risk Management

Construction projects are fraught with risk. The SIP sponsor should develop a construction delivery approach that provides for the management and control of these risks. Risks unique to sound insulation are discussed in the following.

1. Residential SIPs involve renovation on a fast-paced commercial scale, with the additional burden of administrative requirements associated with public funds. Very few contractors have the mix of skill sets required to meet all these needs. This issue can be effectively managed by using experienced sound insulation construction managers as a buffer between the sponsor and the contracting community. Other risk management tools include specifying minimum qualifications or conducting prequalifications for general contractors. Some airports use submission of a construction plan as a weighted portion of the bid to verify that the contractor has grasped the scope of work and has a sound plan for delivering it. Offering smaller projects that contractors must successfully complete prior to bidding on larger projects is an effective means of mitigating the risk of under-qualified contractors.
2. A single contractor's poor performance can significantly harm the reputation of a sound program. The construction delivery approach should minimize this potential by providing timely options for handling poor performance or by reducing poor performance through a series of qualifying activities.
3. SIPs are conducted in occupied homes or schools and require property owner presence during construction. Homeowners who have arranged for vacation time or secured someone to be on-site during construction (or users of schools needing to start classes) may be upset if the schedule does not proceed as they have been informed. The construction delivery approach chosen by the sponsor needs to address contractor performance in regard to staying on schedule. Methods to address this issue should be discussed with the sponsor's legal advisors as part of designing the program. A few examples are:
 - a. Designing time into the specified contract schedule where no new houses are started and any delays can be rectified before continuing.
 - b. Not allowing work to start on a property before all of the product has arrived and been verified.
 - c. Quantified performance reviews conducted on each awarded contract that affect the ability to bid again.

- d. Restrictions on the amount of work one contractor can undertake and successful completion of the first contract before being awarded any additional work.
- e. Daily construction observation so that delays can be noted and resolved before they become an issue.

10.2.5 Scale and Cost

The selected construction delivery approach should match the anticipated scale and pace of the SIP. Most publicly funded programs are judged for reasonableness based on percentages—for example, the ratio of soft costs (administration, design, engineering, outreach) to hard costs (construction). The larger the program, the more room there is in the budget to spread the costs of sophisticated delivery systems that are costly. More complex delivery systems that may meet more community goals need a minimum economy of scale to make them sustainable from a cost standpoint, whereas the most commonly used design–bid–build approach can be used successfully on small or large programs.

10.2.6 Continuity

SIPs typically have durations from a just a few years to over 15 years. An array of construction general contractors, subcontractors, suppliers, and service providers will develop in the community to support completion of the projects. It may take from several months to several years to fully develop the construction-related resources required to successfully support a significant SIP. Based on this reality, program continuity from inception to completion is crucial to maintaining a responsive construction community. Continuity facilitates warranty service work from the contractors and manufacturers since they are present for the continuing work.

That continuity comes in two main forms. First is the presence of a reliable stream of biddable contracts for contractors. This maintains interest and facilitates a contractor investing in building the labor and other resources needed to complete the work. Secondly, a program's policies and procedures for design and construction delivery should provide a framework for ensuring some level of consistency from contract to contract and year to year. This allows contractors to achieve proficiency along with efficiency. Many programs use a pilot phase as a means of testing and adjusting their delivery approach and ramping up a project from inception to an established program. This preliminary effort to thoughtfully establish an approach serves the program well in contractor interest and straightforward management.

10.3 Approach Evaluation and Selection Process

A brief summary of typical construction delivery approaches and the considerations that should go into formulating a delivery approach are presented in Sections 10.1 and 10.2. Steps in the process for selecting a delivery approach and customizing that approach to suit the individual program's needs are:

1. Evaluate the sponsor's existing procurement capability and flexibility for alternative approaches.
2. Assess the capability of in-house or SIP staff (including consultants) in regard to construction delivery expertise.
3. Determine anticipated pace and duration of the program.
4. Determine what kind of management control the sponsor wants to maintain during construction.
5. Determine what management control the sponsor feels comfortable delegating, and to whom.

6. Determine what type of procedures and controls the sound insulation management team intends to use for management of the unique risks associated with SIPs, as described in Section 10.2.
7. Determine if there are elements of the design that are appropriate and beneficial to delegate to contractors.
8. Establish expectations and parameters for program communications and issue resolution during construction.

Finally, select a delivery approach that accommodates the evaluation of items 1 through 8.

It is strongly encouraged that the evaluation of a program's needs and establishment of a construction delivery approach involve the expertise of a construction professional. As previously stated, the construction delivery approaches briefly outlined in Section 10.1, although well established, are just a starting point. Typically these standard approaches are significantly tailored, fine-tuned, and blended with elements of other approaches to meet the specific needs of a program.

10.4 Management of Physical Construction

Although the selected construction delivery approach should define how projects will be managed during physical construction, a brief summary of common approaches and critical components to consider are presented in the following.

10.4.1 Common Approaches

SIPs have used a variety of approaches for the direct management of projects during physical construction, including:

1. In-house/sponsor's staff,
2. Integrated team under the direction of a program manager,
3. Construction manager as part of a design team,
4. Construction manager independent of a design team,
5. Engineering or architectural firm as part of a design team,
6. Engineering or architectural firm independent of a design team, and
7. Some combination of approaches 1 through 6.

Choosing one or more of the management approaches can help address sponsor priorities, including when:

- The sponsor desires some level of control during construction due to the public relations nature of these programs.
- The sponsor desires to establish checks and balances by employing an independent third party to manage the construction phase.
- The sponsor desires to have an integrated approach or a single entity responsible for delivery of the entire project to facilitate streamlined communications and create a single point of accountability.

10.4.2 Critical Components

Regardless of the approach taken to managing actual physical construction, several critical components must be incorporated into the approach to foster success. These components include:

- Definition of entities and individuals with direct authority to act on the sponsor's behalf to conduct administrative and management duties, including scheduling, field directives, prop-

erty owner interaction, work acceptance, RFI processing, change order processing, and payment application processing;

- A streamlined approach to issue resolution, unforeseen conditions, and necessary design modifications;
- A team approach to issue resolution;
- Consistent staffing or supervisory functions to ensure uniform oversight;
- A timely feedback process to allow corrective measures to be implemented; and
- Project documentation systems for the efficient management of federally required project records.

10.4.3 Best Practice Recommendations: Construction Contracting

1. Sponsor understanding of the unique nature of the construction phase of an SIP is critical to making selection of a construction delivery approach a priority during program development.
2. Involve a construction-oriented professional during program development to assist in developing a responsive and sponsor-specific construction delivery approach.
3. When evaluating construction delivery approaches, sponsors need to consider internal capabilities, expertise, and processes, and their willingness to bolster their capabilities as necessary to meet the specific demands of their SIP construction delivery approach.
4. Public relations considerations are paramount in development of a responsive construction delivery system.
5. Take into consideration the intended scale and pace of the individual SIP when selecting a construction delivery approach.
6. It is critical that the selected delivery approach include provisions to manage the unique risks associated with construction in SIPs.



CHAPTER 11

Program Cost Development and Funding

All projects and programs, whether publicly or privately initiated, need to address funding and costs. Sound insulation programs assess cost at various junctures in their development, from program planning to pilot programs to long-range implementation. This chapter addresses the many unique aspects of securing funding and budgeting for costs within a sound insulation program and identifies the elements needed to successfully approach cost development. It will be important in the funding cycles of the program to keep records and produce documentation showing how cost has been developed and managed.

11.1 Funding, Costs, and Eligibility for Reimbursement

The Airport Capital Improvement Plan (ACIP) serves as the primary planning tool for systematically identifying, prioritizing, and assigning funds to critical airport projects. The ACIP also serves as the basis for distributing AIP grant funds.

The ACIP identifies, for Congress and the public, the airport projects (including noise compatibility projects) and their associated estimated costs that will be needed over the ensuing 5 years. In awarding AIP funds to sponsors, the FAA emphasizes funding the highest priority projects first. One of the FAA's primary goals for projects in the ACIP is to improve the compatibility of airports with the surrounding communities. The FAA places a higher priority on funding heavily noise-affected areas over those areas experiencing lower airport noise.

Sponsors should work closely with their FAA point of contact early enough for effective coordination and to meet the necessary milestones, and they should recognize that both national and regional priorities drive the allocation of discretionary funds. For FAA-approved NCP measures, sponsors should coordinate with their FAA program manager or environmental specialist for assistance in determining the scope of eligibility for AIP and/or PFC funding to implement those measures.

11.1.1 Types and Sources of Funding

Normally, funding for carrying out SIPs comes from one or more of the following sources:

- AIP grants,
- PFCs collected by airlines operating at the applicable airport, and
- Proceeds from the airport's disposal of noise land that is no longer needed for noise compatibility purposes.

Less often, implementation is funded through other sources, including airport or local government revenues.

Each fiscal year, the FAA apportions AIP funds into major entitlement categories such as enplanements, non-primary, and state apportionment funds. The FAA distributes the remaining funds to a discretionary fund. Set-aside projects (Airport Noise and the Military Airport Program) receive first attention from this distribution. The funds that remain after the set-asides are true discretionary funds. Because the demand for AIP funds exceeds the availability, the FAA bases the distribution of limited AIP funds on current national priorities and objectives. Projects that rate a high priority will receive higher consideration for funding than those projects with lower priority ratings.¹ For discretionary funds remaining after the Airport Noise and Military Airport Program set-asides, the FAA favors projects that best carry out the purpose of the AIP, with highest priority given to safety, security, reconstruction, capacity, and standards.²

11.1.2 Timetable of Grant Availability

Implementation of a grant agreement may occur only after the sponsor satisfactorily fulfills all prerequisite steps, the FAA formally approves the project for AIP participation, and Congress approves and releases funding.³ Since the federal fiscal year ends September 30th, the FAA generally needs to issue all grants by the third week of August in order to balance records in accordance with the president's management agenda. Grants could be issued earlier in the fiscal year, depending on when FAA funding is appropriated for that year.

A grant offer is a legal document prepared and signed by the FAA and delivered to the sponsor for acceptance in which the FAA formally makes an offer to pay a portion of the allowable costs of an approved AIP project. The signature of the sponsor accepting the grant offer constitutes a grant agreement, which is a binding agreement obligating the sponsor and the United States in accordance with the terms and conditions of the grant document. Part I of the grant agreement, FAA Form 5100-37, is the standard form to be used in preparing the grant offer.⁴

11.1.3 AIP Grant Application Process

The FAA website contains a link to the most current version of FAA Order 5100.39, Airports Capital Improvement Plan (<http://www.faa.gov/airports/aip/acip/>), which provides a complete description of the process for including and prioritizing projects in the ACIP. The most current version of FAA Order 5100.38C, *Airport Improvement Program Handbook* (http://www.faa.gov/airports/aip/aip_handbook/), includes a complete discussion of project eligibility and funding application requirements. Figure 11.1 illustrates an example of the process for obtaining AIP funding for an SIP. Some regional airport offices use variations of this process for airports in their regions. Check with the appropriate airport regional or district office to determine the process they use.

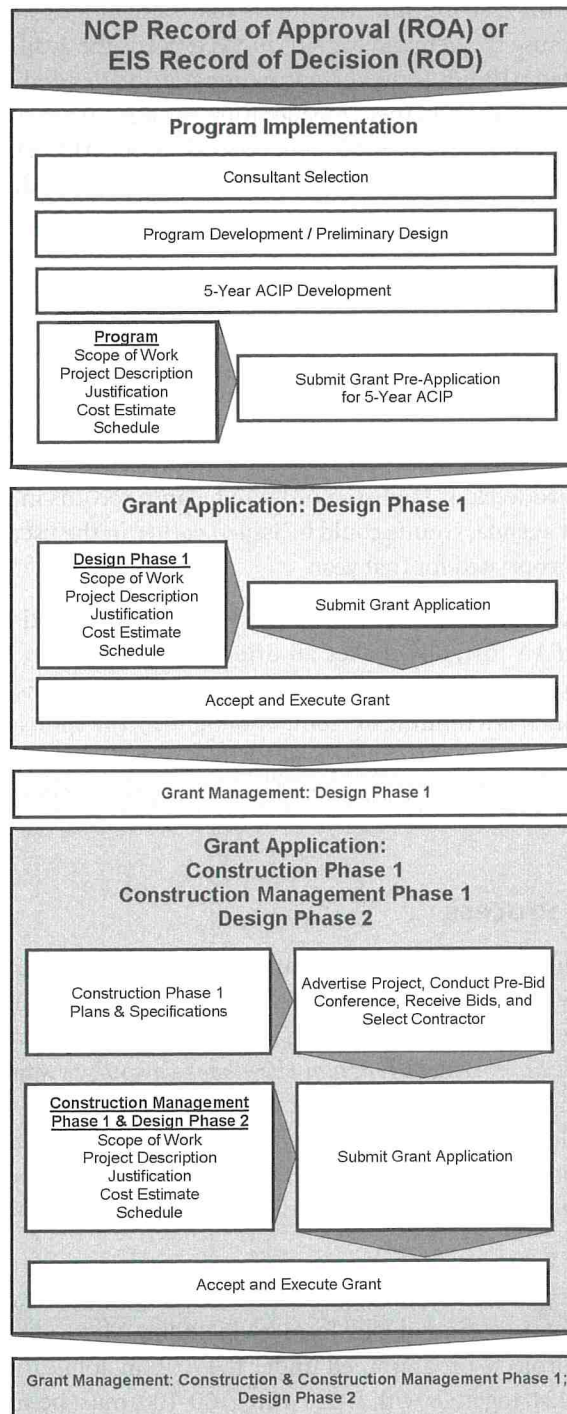
The FAA website also includes the forms necessary to apply for AIP funding (<http://www.faa.gov/airports/aip/>). The forms are available in various digital formats, including Microsoft Word, Excel, and Adobe PDF. For any of the projects programmed under the AIP, an application for federal assistance, Standard Form (SF) 424, together with FAA Form 5100-100, must be submitted to the appropriate FAA airports office before issuance of a grant. SF-424 must be completed in accordance with the instructions on the reverse side of the form and submitted to the FAA

¹ U.S. DOT, FAA, Central Region Airports Division, *AIP Sponsor Guide*, October 1, 2010. §100, pp. 100-101.

² U.S. DOT, FAA, Central Region Airports Division, *AIP Sponsor Guide*, October 1, 2010. §100, pp. 100-101.

³ U.S. DOT, FAA, Central Region Airports Division, *AIP Sponsor Guide*, October 1, 2010. §700, pp. 700-701.

⁴ U.S. DOT, FAA, FAA Order 5100.38C, *Airport Improvement Program Handbook*, June 28, 2005. Appendix 6.



Graphic courtesy of URS Corporation.

Figure 11.1. Example process for applying for AIP funding.

with all supporting documentation, sponsor assurances, and certifications. Some regional airport offices have prepared variations of these forms and instructions for use by airports in their regions. Before completing a form, please check with the appropriate airport's regional or district office to determine which form to use.

The completed SF-424 must be accompanied by the supporting documents listed in the following, as appropriate. The FAA may request, on a case-by-case basis, additional information to support other federal and local requirements.⁵

A. Program Narrative and Cost Estimates

A narrative summary statement of the project must be provided. The summary must include a description and justification for the project to be accomplished. Additionally, estimates showing the basis for the project budget must be furnished in sufficient detail to determine whether the project costs appear to be reasonable.⁶

B. Map

Applicants must provide a map, at least 8½ in. × 11 in., that depicts and identifies the limits of the proposed project. The map should show the boundaries and proposed property rights (i.e., avigation easement) of each parcel of land included in the project.⁷

C. Identification of Environmental Requirements

All AIP projects must be either categorically excluded or accompanied by an environmental assessment that resulted in a finding of no significant impact (FONSI) or by an environmental impact statement prepared in accordance with FAA Order 5050.4B, National Environmental Policy Act (NEPA) Implementing Instructions for Airport Projects.⁸ Noise compatibility projects must receive appropriate FAA environmental determinations prior to consideration for AIP funding. FAA Order 5050.4B indicates which noise compatibility projects require an environmental assessment or environmental impact statement and which are categorically excluded.⁹ A link to the most current version of this document is available on the FAA website (currently <http://www.faa.gov/airports/environmental/>). For example, a historic structure may be proposed for sound insulation, thereby necessitating a determination of potential environmental impacts due to the treatments. This is discussed further in Chapter 6 of these guidelines.

D. Federal Register

The FAA may accept a sponsor's application at any time. Special directions are published annually in the Federal Register, which provides a deadline for submission of applications under the AIP. This announcement is for the upcoming fiscal year and covers only sponsor entitlement and cargo funds. The announcement typically states that "Absent an acceptable application by May 1, [current year], FAA will defer an airport's entitlement funds until the next fiscal year." This notice applies to "those airports that have had entitlement funds apportioned to them, except those non-primary airports located in designated Block Grant States."¹⁰ Sponsors are advised, as appropriate, to comply with the schedule in the Federal Register. However, regions may request sponsors' submissions at an earlier date to meet regional needs.¹¹

⁵ U.S. DOT, FAA, FAA Order 5100.38C, *Airport Improvement Program Handbook*, June 28, 2005. Appendix 6. §1011, p. 172.

⁶ U.S. DOT, FAA, FAA Order 5100.38C, *Airport Improvement Program Handbook*, June 28, 2005. Appendix 6. §1011 (a), pp. 172-173.

⁷ U.S. DOT, FAA, FAA Order 5100.38C, *Airport Improvement Program Handbook*, June 28, 2005. Appendix 6. §1011 (b), p. 173.

⁸ U.S. DOT, FAA, FAA Order 5100.38C, *Airport Improvement Program Handbook*, June 28, 2005. Appendix 6. §1011 (c), p. 173.

⁹ U.S. DOT, FAA, FAA Order 5100.38C, *Airport Improvement Program Handbook*, June 28, 2005. Appendix 6. §805, p. 134.

¹⁰ U.S. DOT, FAA, Great Lakes Region Airports Division, Regional Guidance Letter 5100.20, December 12, 2007, §8, p. 4.

¹¹ See note 4. §1012, p. 173.

11.1.4 Sponsor Assurances

When airport owners or sponsors, planning agencies, or other organizations accept funds from FAA-administered airport financial assistance programs, they must agree to certain obligations (or assurances). These obligations require the recipients to maintain and operate their facilities safely and efficiently and in accordance with specified conditions. These obligations are established either in the acceptance of the grant offer or in restrictive covenants to property deeds.¹²

AIP sponsors are advised to retain a copy of the grant assurances for each project accomplished under the AIP. Obligations imposed by the grant assurances extend beyond the completion of the project. The duration of these obligations depends on the type of recipient, the useful life of the facility being developed, and other conditions stipulated in the assurances.¹³

Two sets of assurances are available depending on the type of grant: (1) Airport Sponsor Assurances and (2) Noise Compatibility Assurances for Non-Airport Sponsors. The current versions of these assurances can be found on the FAA's website at http://www.faa.gov/airports/aip/grant_assurances.

PGL 12-09 stresses that AIP-funded SIP projects “meet all federal procurement and contract requirements including the Buy American Preference requirements of Title 49 United States Code 50101.”¹⁴ These requirements are further addressed in PGL 10-02, Guidance for Buy American on Airport Improvement (AIP) or American Recovery and Reinvestment Act (ARRA) Projects, issued by the FAA on February 24, 2010.

Note: Program sponsors are advised to have their legal departments consult closely with their ADO to ensure that their program contract bid documents contain the requirements of the Buy American Act with respect to general provisions and certifications of conformance by manufacturers and contractors.

ACRP Project 11-01, Topic 04-04, has resulted in the publication of *ACRP LRD 18: Buy America Requirements for Federally Funded Airports*. It is a useful reference for sponsors and consultants who have questions regarding Buy American requirements for AIP funded programs such as SIPs.

11.1.5 Reimbursement

The AIP does not reimburse sponsors for the full amount of a project's expenses. The amount of reimbursement will vary with the type of sponsor. This participation can change with each reauthorization action. As of the date of this publication, the following AIP participation rates apply:¹⁵

- For large and medium primary hub airports, the federal share is 75% of AIP-eligible expenses, with the exception of noise program implementation, which is 80% federal participation.
- For remaining airports (small primary, non-primary, relievers, and general aviation airports), the AIP participation rate is currently set at 95% of AIP-eligible costs.

The U.S. DOT is implementing a new department-wide electronic grant payment system, Delphi eInvoicing System. This system will provide a web-based standardized portal for grantees to electronically request grant payments and monitor payment status. All airport sponsors, including those currently submitting grant payment requests through Electronic Clearing House Operation, will be required to transition to the new system. The DOT and FAA anticipated that

¹² See note 1. §720, p. 700-4.

¹³ See note 1. §720, p. 700-4.

¹⁴ U.S. DOT, FAA, PGL 12-09, August 17, 2012, Attachment A, §812 (c)(2), p. 1-5.

¹⁵ See note 1. §100, pp. 100–101.

this training and system deployment would begin in spring/summer 2012. Additional information is available on the FAA website at: http://www.faa.gov/airports/aip/grant_payments.

A sponsor may not seek AIP reimbursement prior to incurring costs. Cash advances are not permitted. The sponsor must prepare an SF-271 for each drawdown transaction. Sponsors must retain supporting documentation for a period of 3 years from the date of project closeout.¹⁶

The Office of Management and Budget (OMB) Circulars A-102 and A-110, as well as 31 CFR Part 205, govern payment to recipients for financing operations under federal grants and other programs. These regulations require that payment to a grantee be limited to the minimum amounts needed and be timed so as to be in accord only with the actual, immediate cash requirements of the grantee in carrying out the approved project.¹⁷

11.1.6 Best Practice Recommendations: Funding, Costs, and Reimbursement

1. Consult with the program's FAA point of contact regarding the appropriate time to update the ACIP and any other process the point of contact may use to identify long-range funding needs.
2. Consult with the program's FAA point of contact to confirm AIP and/or PFC funding eligibility to implement each element of the SIP.
3. Consult with the program's FAA point of contact to determine the appropriate grant application process and timeline.
4. Be aware of the current federal AIP participation rate for the applicable airport.
5. Have program staff trained to use the current grant payment system.

11.2 Establishing Cost Goals and Priorities

Since SIPs use public funds, the program sponsor and delivery team are accountable to the funding or regulatory agencies. Formalizing cost goals and priorities is sound practice. Goals and priorities typically start out broadly defined and are revisited and fine-tuned as a program progresses through implementation.

11.2.1 Establishing Importance of Cost

SIPs involve myriad stakeholders, including but not limited to the FAA, the airport management entity, the municipal entity(s) in the area in which the program resides, airline companies, homeowner participants, and the general public. Each entity will have a unique perspective affecting cost. In order to develop a cost strategy sensitive to a sound insulation program's needs, it is essential to determine a general consensus regarding the importance of establishing and managing cost. The sponsor determines whether this is done through stakeholder interaction or through indirect analysis. A proactive approach to developing the importance of cost will pay significant dividends should program cost become an issue that attracts public interest.

¹⁶ See note 1. §1500, pp. 1500–1501.

¹⁷ See note 1. §1500, pp. 1500–1501.

Questions to address with stakeholders include:

- Is it acceptable to use similar, established sound insulation programs as a benchmark for your program's cost?
- Based on general property values in the community, is there a maximum ratio of property value to program improvements establishing a not-to-exceed per-property cost?
- Do the various funding participants have annual, per-property, or other funding limits?
- Does the program have an established or desired duration?
- Are there cost expectations by stakeholders?
- Is a cost-benefit analysis appropriate?

These questions serve as a starting point in evaluating specific cost issues, resulting in the clear establishment of the importance of cost to the program.

11.2.2 Establishing Priorities

Program sponsors need to consider the many competing elements of a sound insulation program to determine the level of importance of each and then prioritize in regard to cost. Once cost importance and sensitivity are defined, develop priorities around these realities. Typical issues to evaluate and prioritize include:

- Participation boundary issues,
- Public outreach components and effort,
- Demonstration home,
- Sound insulation program office,
- Program administration (using existing in-house resources verses outsourced administration or new dedicated in-house personnel),
- Integrated verses a multi-entity program delivery team,
- Treatment offerings,
- Product quality and features (higher quality and more features versus lower cost),
- Green initiatives and energy efficiency issues (whether to meet or exceed minimum requirements),
- Air quality issues (passive or active system approach),
- Retrofit verses unit replacement approach,
- Egress approach,
- Hazardous (asbestos and lead-based paint) materials remediation and program liability,
- Construction delivery approach,
- DBE participation requirements,
- Warranty durations, and
- Acoustical testing.

Once all issues specific to the program have been evaluated in regard to desirability, level of importance, and cost implication, stakeholders are in a position to make informed decisions about program features and elements while understanding their cost implications. This is a juncture that lends itself well to a cost-benefit analysis. Recording the results of these efforts in a written document summarizing the cost issues evaluated, stakeholder input regarding cost, and any consensus that was established is an important activity to aid future decisions.

This process should not be viewed as a one-time effort but rather an activity undertaken during several phases of program development and implementation. Ongoing attention to these matters creates a process responsive to cost realities over the life of a program. Established priorities will likely be referred to many times and help guide cost decisions as a program progresses from initial inception to completion.

11.2.3 Program Cost Development

The unique nature of sound insulation programs does not lend itself well to the use of the standard cost estimating practices for estimating administrative, professional, and construction costs of typical public works projects. However, the professionals serving the sound insulation industry have developed techniques that can be used to develop accurate projections of program cost. What follows is a summary of cost estimating techniques and issues unique to the sound insulation industry.

11.2.4 Preliminary Costing

Preliminary costing takes place during program planning as part of the Part 150 study. Costing should be completed by a professional with direct experience in the sound insulation industry since this process will require access to cost data from other sound insulation programs.

Preliminary costing is usually prepared using benchmarking or a unit pricing approach. Both of these techniques rely on taking cost data from established sound insulation programs with characteristics similar to the anticipated program, then extrapolating preliminary costs and making adjustments to accommodate the new program.

11.2.5 Cost Refinement

The majority of detailed program costing and refinement takes place during the initial phase of design, as part of deliberations with the professionals selected to carry out the program's first phase of implementation. This activity would best be accomplished within the Part 150 study when sufficient time is available for such an intensive activity, but it rarely occurs during that time. The scope of Part 150 studies is so broad that attention to SIP costs is often left to be refined and further developed once the SIP starts. Often this generates some concern when funding sources and program sponsors are informed that the program will cost more than stated in the Part 150 study.

Program cost refinement includes the finite definition of program elements and costing of those elements. The common elements to define and price include:

- Program administration,
- Public relations,
- Program-specific facilities,
- Professional design and construction services,
- Testing costs, and
- Construction costs.

11.2.6 Components of Program Cost

Sound insulation programs have cost components that are similar to other public works projects in name but considerably different in practice due to the unique nature of conducting publicly funded environmental remediation on private property. Accordingly, use of standard costing curves and other traditional tools for cost estimating public works projects is not effective for estimating sound insulation program costs. Provided in the following is a brief summary of the general cost components involved in sound insulation and their unique characteristics to consider when developing cost.

A. Program Administration

Typical program administration tasks for a public works project include securing funding, hiring design professionals, providing design direction, and administering design and construction contracts. Sponsors will need to determine if administration will be performed by existing

in-house staff and established departments or if administrative duties will be delegated to an outside team.

Due to the unique aspects of sound insulation, additional administrative tasks need to be undertaken by the sponsor. These tasks include public education and outreach, participant identification, solicitation and signup, homeowner agreement processing, and easement acquisition. An important technical administrative task is the establishment of program guidelines and standards, which will include treatment offerings, product quality and features, green initiatives and energy efficiency issues, air quality issues, retrofit versus unit replacement approach, egress approach, hazardous materials remediation, construction delivery approach, DBE participation requirements, wage rates regulations, and warranty durations.

Since programs have durations from a few years to in excess of 10 years, it is important to develop standard policy and procedure documents to provide consistency over the extended program duration. These unique, one-time, and recurring administrative efforts often involve the establishment of new sponsor positions or the use of professional consultants, and they need to be considered in developing anticipated program costs.

B. Public Relations

As discussed in these guidelines, sound insulation programs involve myriad stakeholders with a variety of perspectives, so programs require a proactive approach to public relations. The one-time start-up and establishment costs of this task and annual recurring costs need to be considered. One-time and establishment costs of public relations may include initial stakeholder meetings, establishment of a written public relations plan, preparation of standard literature, building the program's website, and designing a newsletter. Recurring costs typically include public presentations, distribution of informational materials, and response to almost daily inquiries regarding a variety of issues. In most cases, establishment of a public relations plan requires an experienced public relations manager or team.

C. Program-Specific Facilities

Whereas most public works projects conduct administrative duties within the confines of their existing physical office space, sound insulation programs typically use additional facilities to support their interactions with program participants and their intense administrative and public interaction functions. Program-specific facilities may include a product showroom, a demonstration home, and a dedicated sound insulation administrative office.

Product showrooms are used to display the products that will be incorporated into an SIP, allowing prospective homeowner participants to become familiar with SIP product offerings. Similarly, demonstration homes typically involve a program acquiring an individual home within the SIP boundaries and sound insulating the home using the various products to be used for the program. Prospective homeowner participants may tour the home to become familiar with SIP treatments.

Since SIPs involve considerable interaction with the public and individual property owners, many SIPs use a dedicated sound insulation office for ready access to the public. This helps create a positive public image while providing focused delivery of services. The establishment and carrying cost of these facilities should be considered when developing anticipated cost.

D. Professional Fees: Architectural, Engineering, and Acoustical

Determining appropriate professional fees is a difficult task given the unique nature of sound insulation programs. Many professional organizations and government agencies provide curves and equations for determining appropriate professional fees associated with construction projects; these curves are usually based on project size and level of complexity. Such standard

approaches are not appropriate for SIPs because the level of design and administrative effort on renovation projects in multiple homes is usually greater as a percentage of construction cost than, for example, a large new runway project. Renovation design efforts require the analysis of existing conditions as well as the design of the new treatments. SIP treatments, while generally consistent over a program, are applied in a custom fashion to each home. Additionally, standard cost curves and equations do not reflect the added effort associated with an SIP's administrative and public relations functions. Professional fees for sound insulation programs are best estimated by preparing well-defined scopes and associated effort schedules, reflecting the unique design, administrative, public relations, program-specific facilities, and testing aspects of a program as described in AC 150/5100-14D, Architectural, Engineering, and Planning Consultant Services for Airport Grant Projects.

E. Professional: Construction Related

Construction-related professional fees also should not rely on available standard public works methodologies. SIP construction contracts include many third-party individual property owners and, in the case of residential SIPs, multiple and geographically diverse construction locations. These realities require more daily coordination and communication with the property owners, as well as making allowances for travel between construction locations. Cost estimation is based on scope/effort estimates and/or experienced consultant advice regarding the level of staffing and services necessary for successful execution of the construction phase.

F. Testing

A sound insulation program's acoustical testing guidelines are designed to determine eligibility and confirm compliance with a program's noise reduction requirements. The knowledge that homes will be tested after construction as part of verifying treatments for FAA funding instills a need for close construction monitoring that ensures construction details are carried out as designed to achieve noise reduction. As contractors new to sound insulation treatments often learn, installation details for acoustical products are more complex than regular installations. These complex construction details need to be built correctly to ensure that the testing results are as needed to meet FAA goals and maintain funding. Reinstalling windows or doors after testing indicates that the installation was not performing properly, which is inconvenient to homeowners and awkward for programs. Field representation and other construction monitoring activities that ensure construction is completed as detailed for successful post-testing are beneficial costs to factor into program planning.

G. Construction Costs

The construction component of a program makes up a majority of overall costs and is therefore a significant cost component to evaluate. Similar to other components of program costs, traditional means of estimating construction costs are not very accurate. Programs require a blend of construction services and skill sets not typically available in the construction industry, and these are not well represented by traditional estimating practices. Sound insulation programs involve government-funded, large-scale, fast-paced upgrades to buildings as well as specialized acoustical retrofits. These require a blend of project contractor needs that is not usually well supported by the construction community.

Contractors experienced in residential construction may possess the retrofit trade skills but lack the administrative and financial sophistication necessary to manage a large, fast-paced, government-financed project. General contractors specializing in large public works may be able to handle the administrative and financial aspects of SIPs but lack the residential construction knowledge and homeowner sensitivity necessary to manage detailed, day-to-day work. So it is a unique blend of public works general contractor sophistication coupled with residential contractor trade skills that is necessary to succeed in sound insulation programs.

Each of these contractor types—public works general contractor and residential contractor—has completely different pricing and overhead structures. The blending of these contractor types results in a hybrid, which traditional construction costing approaches do not support. Accordingly, professionals in the sound insulation industry have developed approaches for dealing with this hybrid situation.

11.2.7 Construction Cost Estimating Approaches

A variety of construction cost estimating approaches are used by practitioners in the sound insulation industry to establish costs. A few of the most common approaches are summarized in the following:

A. Benchmarking

Benchmarking is a common approach to estimating construction cost in the sound insulation industry. Under this approach, programs of similar characteristics and components are identified for comparison. Characteristics and component cost information are obtained from those programs, and then compared to the components of the program under development. A program under development may benchmark against multiple programs in order to obtain component cost information which is most similar to the anticipated program. When benchmarking, it is common to make adjustments to the data to account for locality, wage rates, construction typology, or differing general conditions. This approach relies on the use of an established sound insulation consultant who would have access to the data.

B. Unit Pricing

The unit pricing approach is the most common form of sound insulation construction cost estimating. Under this approach, a program's anticipated construction treatments are broken down into logical unit price items. The unit price items may be broadly defined to include typical units of construction (i.e., add a 2-ton air conditioner) or narrowly defined (i.e., break metal window surround). Unit prices are established from other similar programs (benchmarking) and applied to the anticipated quantities of unit price items for the program under development. Use of benchmarked unit prices relies on access to other programs' cost data.

Unit prices can also be established from detailed estimates or from estimating software such as that provided by RSMeans.¹⁸ However, due to the hybrid nature of this specialized industry, estimates are best developed by professionals familiar with the sound insulation industry. Construction estimating software often needs to be further programmed with specific sound insulation data that are not commercially available.

C. Pilot Programs

Pilot programs offer an outstanding opportunity for sponsors to determine the actual costs of the various program treatments they are providing. Typically, a pilot program includes the preparation of construction bid documents for a small group of dwellings as an initial phase in a sound insulation program. The bid documents require bidders to provide detailed cost information (schedule of values), which can be used by the program to establish the anticipated costs for various treatment offerings. The data gleaned from pilot programs can be used to adjust program treatment options to meet budget goals and to perform a cost-benefit analysis in advance of implementing the full-fledged program.

¹⁸ See RSMeans Reed Construction Data website, <http://rsmeans.reedconstructiondata.com>.

D. Contractor Estimates

Using local specialty contractors to prepare construction cost estimates for various treatment offerings can also be effective. Under this approach, specifications, details, and plans are prepared for various treatment offerings and submitted to local specialty contractors to estimate. The various specialty contractor estimates can be combined, general condition costs added, and overhead and profit applied, resulting in an overall estimate of cost. This approach has its limitations based on the market competitiveness of the selected specialty contractors and the ability of the estimator to define general condition costs, market overhead, and profit rates.

E. Other Estimating Resources

Section 5 of *Guidelines for Sound Insulation of Residences Exposed to Aircraft Operations*¹⁹ provides detailed guidance for estimating SIP construction costs and can be used as a resource for the type of costs to be estimated in SIP construction; however, the actual cost data will need to be updated.

11.2.8 Cost Management

Once a program's cost goals and priorities are established, costs can be effectively managed through timely data collection, analysis, and comparison to defined goals or budgets. For effective cost management, preliminary budgets should be prepared for all aspects of the anticipated costs of the program. The preliminary budgets should be adjusted and refined as a program moves from inception to initial construction phase, guided by established priorities and stakeholder interaction. Use cost-benefit analysis when appropriate. Once a program is under way, cost data should be collected for each element of the budget in a timely manner to allow for annual reviews and adjustments per the program's established goals and priorities.

11.2.9 Best Practice Recommendations: Establishing Costs

1. A proactive approach to developing the importance of costs will pay significant dividends should program cost become an issue that attracts public interest.
2. Program sponsors need to consider the many competing elements of a sound insulation program to determine the level of importance of each, and then prioritize these in regard to cost.
3. The unique nature of conducting publicly funded environmental remediation on private property does not lend itself well to the use of standard cost estimating practices used for estimating the administrative, professional, and construction costs of typical public works projects.
4. Professional fees for sound insulation programs are best estimated by preparing well-defined scopes and associated effort schedules, reflecting the unique design, administrative, public relations, program-specific facilities, and testing aspects of a program per AC 150/5100-14D.
5. Field representation and other construction monitoring activities that ensure construction is completed as detailed for successful post-testing are beneficial costs to factor into program planning.
6. Once a program is under way, cost data should be collected for each element of the budget in a timely manner to allow for annual reviews and adjustments per the program's established goals and priorities.

¹⁹Department of the Navy, Naval Facilities Engineering Command, *Guidelines for the Sound Insulation of Residences Exposed to Aircraft Operations*, as referenced in FAA AC 150/5000-9A, April 2005.

11.3 Variables Affecting Cost

There are many variables that affect the cost of an SIP. Some of the variables that have the greatest impact are discussed in the following.

11.3.1 Regulatory

A. Prevailing Wage Rates

Publicly funded projects require that the tradespeople who conduct the actual construction work be paid according to regulated wage rates defined by the type or classification of individual trades (i.e., carpenter, welder). These rates may include federal-, state-, or municipality-established wage rates. The sponsor is responsible for defining which rates apply to a program based on the funding sources. Since multiple funding sources are used in most SIPs, the highest applicable standard will prevail as the required pay rate. Residential prevailing wage rates often apply to programs. However, in the absence of published residential rates, commercial or building rates apply. Prior to bid, the sponsor may request a special determination of residential rates when the standard residential wage rate schedules do not provide for the anticipated trade classifications to be used on a program. Commercial and building prevailing wage rates are typically higher than residential rates and can increase program costs if residential rates are not available at the time of bid.

B. Policies and Standard Procedures

Once policies and procedures are established and documented in a PPM, they constitute the primary driver of costs for a program. Accordingly, it is critical that a program's policies and procedures be developed to include projected cost data, which facilitates informed decision making and cost-benefit analysis. To be responsive to evolving cost issues, anticipate updating the PPM throughout the course of the program.

C. Acoustical Sampling and Testing Requirements

In order for an SIP to be funded with AIP grant funding, the sponsor must follow the sampling and testing criteria specified in FAA PGL 12-09, Attachment A, Table 2.²⁰

Reimbursement for initial and subsequent phase testing is limited to 10% of the residences of a particular type (e.g., brick, wood frame) unless the FAA has approved the sponsor's written justification for requesting additional testing. The ADO may approve up to 30%. Requests for more than 30% must be approved by FAA Headquarters, Office of Airport Planning and Programming, Planning and Environmental Division.²¹

PGL 12-09 does not specify how many (or how few) homes may be considered a "particular type" for testing purposes. Nor is it clear how many (or what percentage) of homes of a given type must meet the interior noise eligibility threshold for that type of home to qualify for acoustical treatment. Sponsors and consultants have asked the following questions regarding the PGL's sampling and testing criteria:

- How many (or how few) homes can be considered of a "particular type" for testing purposes?
- How many types of homes can a program define?
- How many (or what percentage) of homes of a given type must meet the interior noise eligibility threshold for that type of home to qualify for acoustical treatment?

²⁰ See note 14.

²¹ See note 14. Attachment A, §812 (c)(2), Table 2, p. 1-7.

Program sponsors and consultants should consult with their local ADO for clarification on these issues.

D. Existing Code Deficiencies

Many municipal jurisdictions require corrective action if code deficiencies are encountered as part of a significant renovation project. These corrective measures can add significant cost to a program and should be addressed in advance with local municipal code and permit officials. FAA reimbursement under Part 150 NCP programs is limited to code corrections that result as part of the direct installation of SIP treatments and will not cover broader code deficiencies that could become a problem when trying to close a construction permit. Some programs provide local funding to cover limited code issues, usually based on a fixed maximum cost or a defined scope of work. When a program is based on an EIS rather than a Part 150 study, the potential exists for the community to negotiate code corrections as part of the program.

E. Environmental Concerns

Environmental issues such as removal of lead-based paint, asbestos removal, air quality, and energy efficiency requirements continue to significantly affect program costs. Planning for these costs requires technical knowledge of the age of the buildings to be treated and the potential materials to be encountered.

11.3.2 Community Considerations

A. Retrofit Versus Unit/System Replacement

Installation of acoustical treatments can be accomplished by retrofitting or by complete replacement of existing installations and systems. Retrofit typically involves a less intrusive and therefore less costly installation using a portion of the existing components of the window, door, HVAC, and electrical system to accomplish installation of the acoustical treatments. On the other hand, unit/system replacement typically involves the complete removal of existing windows and doors to the rough opening and complete removal of existing electrical services and HVAC systems, resulting in increased home disruption and construction costs.

Several issues should be considered when determining the type of installation approach. Retrofitting involves a reliance on existing equipment and building components for the retrofitted installations to function and perform properly. Should the existing equipment or building components be in unsatisfactory condition, improperly installed, or in a state of disrepair or decay, the retrofitted installations may not perform as desired or may result in dissatisfied homeowners. Many programs address the existing condition issue during home evaluations and specify unit/system complete replacement only when needed to address unsatisfactory existing conditions.

Another issue to be considered when determining the installation approach is an evaluation of the community's established renovation norms. These norms can typically be established during initial assessment of homes for inclusion in an SIP or during a pilot phase. By matching the renovation norms of the community, a program can typically gain broad acceptance of acoustical treatment installation methods.

B. Treatment Offerings

The scope of program acoustical treatment offerings is directly related to program cost. Treatment offerings should be tailored for individual SIPs to meet the noise reduction goals as well as to address community concerns regarding aesthetics and existing architecture. Primary acoustical treatments necessary to meet noise reduction goals, such as window and door installations, typically have an ancillary impact on energy use, interior humidity/moisture control, air quality, ventilation, and the

like. These ancillary noise-treatment-related impacts need to be evaluated and addressed as part of a program as well.

C. Scale, Pace, and Consistency

The scale, pace, and consistency of bid cycles in a program have a significant impact on program costs. Typically, the larger the size of construction contracts and more regularly and consistently a program awards construction contracts, the lower the per-dwelling unit cost. This is primarily due to the well-understood concept of economy of scale.

11.3.3 Design

A. Product Selections

The products available to accomplish sound insulation can vary considerably in quality, features, and price. Accordingly, it is advisable during program formulation that the sponsor be exposed to the full range of available products and features and their related cost implications for the program. A survey of the quality and features of renovation and repair products most often used within the communities to receive sound insulation treatment may assist in selecting products that are commonly acceptable and in accordance with a community's expectations.

11.3.4 Best Practice Recommendations: Cost Variables

1. The sponsor or the sponsor's consultant should define which wage rates apply to a program based on the funding sources. Since multiple funding sources are used in most SIPs, the highest applicable standard will prevail as the required pay rate.
2. It is critical that a program's policies and procedures be developed to include projected cost data, which facilitates informed decision making and cost-benefit analysis.
3. Take into consideration environmental issues such as removal of lead-based paint, asbestos removal, air quality, and energy efficiency requirements, which continue to significantly affect program costs.
4. Understand the established renovation norms active in the community to facilitate cost-appropriate acoustical treatment installation methods.

Project Reporting and Closeout

Agencies and sponsors implementing an SIP are sometimes not fully aware of project reporting and closeout requirements and consequently need to generate reports and records at closeout that could have been created and updated during project activities. Failure to maintain accurate records for programs funded by the AIP can have negative results. Some airports have had funds withheld until sponsors provide appropriate documentation to comply with federal assurances. It is advisable that a reporting and closeout plan be given a high priority when establishing a program work plan, whether sponsors intend to handle administrative tasks in house or use consultants for program management activities. SIPs and their associated reporting and closeout activities generate a tremendous volume of files and documentation. All of these items must be available for audit.

This section of the guidelines outlines reporting and closeout requirements; however, managing a successful SIP requires agencies and sponsors to review, in detail, the reporting requirements and closeout procedures outlined in *AIP Handbook*, FAA Order 5100.38C and 49 CFR 18.40.¹ It is advisable that sponsors or grant administrators consult with their regional FAA ADO to verify what submittals they require since the FAA ADO may have its own requirements for reporting and closeout activities.

12.1 Regulatory Agencies

SIPs are large, complex projects that require the assistance of multiple agencies and the careful coordination of internal program staff. It is sometimes the case that an SIP is the largest single project receiving funding in an airport's ACIP. Because of the amount of funding required for these types of projects, it is likely that an audit will take place at some point during the project. Understanding regulatory agencies and the role they serve is crucial to successfully preparing for the possibility of an audit.

The following agencies regulate and provide guidance on reporting and closeout procedures. An SIP's guidelines should incorporate the reporting and closeout regulations disseminated by these agencies.

12.1.1 U.S. Department of Transportation

The U.S. DOT is a federal department administered by the United States Secretary of Transportation. The mission of the U.S. DOT is to "serve the United States by ensuring a fast, safe, efficient, accessible, and convenient transportation system that meets our vital national interests

¹ U.S. DOT, FAA, FAA Order 5100.38C, *Airport Improvement Program Handbook*, June 28, 2005.

and enhances the quality of life of the American people, today and into the future.”² The FAA is an agency within the U.S. DOT. Open and consistent communication with the FAA ADO is encouraged throughout each step in an SIP, especially during project reporting and closeout. While Sections 12.2 and 12.4 outline reporting and closeout requirements, the ADO may have its own requirements and should be consulted. If there is any doubt regarding what is required when reviewing the published regulations outlined in Section 12.2, contact the local ADO. FAA representatives are well versed in the requirements and can provide guidance.

12.1.2 Office of Management and Budget³

The OMB’s predominant mission is to assist the president in overseeing the preparation of the federal budget and to supervise its administration in executive branch agencies. In helping to formulate the president’s spending plans, the OMB evaluates the effectiveness of agency programs, policies, and procedures; assesses competing funding demands among agencies; and sets funding priorities. The OMB ensures that agencies’ reports, rules, testimony, and proposed legislation are consistent with the president’s budget and administration policies. In addition, the OMB oversees and coordinates the administration’s procurement, financial management, information, and regulatory policies. In each of these areas, the OMB’s role is to help improve administrative management, develop better performance measures and coordinating mechanisms, and reduce any unnecessary burdens on the public.

Audits may be required for SIPs and must be conducted per the OMB’s standards and regulations. Section 12.5 provides more information on audits of SIPs.

12.1.3 Office of Inspector General (OIG)⁴

The Office of Inspector General conducts independent audits, inspections, and investigations that advance the missions of the Department of State and the Broadcasting Board of Governors. The OIG (among other things) provides leadership to promote integrity, efficiency, effectiveness, and economy, while preventing and detecting waste, fraud, abuse, and mismanagement of government funds.

If an SIP is audited, the OIG actively participates in the audit process. Section 12.5 provides more information about the audit process.

12.2 Reporting and Closeout Guidelines

In the following are the FAA requirements and specific regulations that deal with project reporting. Always consult with the regional ADO regarding any questions on the reporting requirements. Use the FAA as a source of information and direction.

12.2.1 AIP Handbook, FAA Order 5100.38C

The *AIP Handbook*, FAA Order 5100.38C, Chapter 12, Section 2, Paragraph 1221⁵ requires that a project sponsor ensure that project work is carried out in accordance with plans and specifications, that time schedules are observed, that federal labor and civil rights provisions are followed, and that all other terms and conditions in the contract documents and grant agreement are implemented.

²What We Do, United States Department of Transportation, updated Dec. 19, 2011, <http://www.dot.gov/about.html#whatwedo>.

³See the website of the Office of Management and Budget, www.whitehouse.gov/omb.

⁴See the website of the Office of Inspector General, <http://oig.hhs.gov/>.

⁵See note 1, Chapter 12, Section 2, Paragraph 1221, Sponsor’s Responsibilities.

12.2.2 49 CFR 18.40

Monitoring and reporting requirements for grantees are addressed in 49 CFR 18.40. Grant recipients are responsible for managing the day-to-day operations of grant activities to ensure compliance with applicable federal requirements. They must also submit a performance report for each fiscal quarter that, at a minimum, includes the following items:

1. A comparison of proposed objectives to actual accomplishments for the reporting period. (Outline the baseline schedule, revised schedule, and actual completion date.)
2. Reasons for any slippage or lack of accomplishment in a given area.
3. Impacts on other AIP-funded projects.
4. Impacts to PFC,⁶ facilities and equipment, or owner-funded projects.
5. Identification and explanation of any anticipated cost overruns. (Provide a summary of additional costs, change orders, and so forth.)

When grants have been awarded for SIP projects with multiple phases that are covered under a single grant, grant recipients should submit performance reports for each project. The tracked accomplishments will vary according to the type of project. Following are recommended task items for two types of projects: design only and construction/equipment.

A. Design-Only Project Task Items

- Completed grant agreement.
- Notice to proceed to architectural or engineering firm.
- Submittal of final plans and specifications.
- Submittal of design grant closeout (SF-271, invoices).

B. Construction/Equipment Project Task Items

- Completed grant agreement.
- Notice to proceed to contractor.
- Substantial completion.
- Final acceptance.
- Submittal of grant closeout documentation.

12.3 Documentation Organization

It is imperative that airport sponsors or grant administrators implement a project reporting and closeout plan for all SIP-grant-funded projects. If the airport sponsor or grant administrator assists with program management activities, the sponsor or grant administrator should include specific tasks in the scope of work to clearly identify FAA reporting timelines and required reports. It is not uncommon for a sponsor to delegate the responsibility of tracking eligible grant expenses to its finance department.

12.3.1 Flow Chart

Airport sponsors and grant administrators need to invest the time to map out the entire reporting process. A step-by-step diagram and reporting structure take the guesswork out of the decision-making process. It is recommended that sponsors and grant administrators consider using a certified workflow process consultant to assist with developing these processes. Key sponsor decision makers and consultant staff should also participate in the process—an essential

⁶U.S. DOT, FAA, AC 150/5000-12, Announcement of Availability – Passenger Facility Charge (PFC) Application (FAA Form 5500-1), July 15, 1994.

step that allows decision makers the opportunity to provide input and see what is required to successfully manage an SIP.

A reporting and closeout workflow also helps to strengthen relationships between the community and the airport. When key decision makers are involved in the setup, they are able to see how the SIP touches more than just noise-affected property owners. See Appendix E, Exhibit 1 for a sample administrative workflow diagram.

12.3.2 Consultant Agreements

It is strongly encouraged that sponsors and grant administrators create a separate task item within their consultant agreement that specifically addresses the scope of work for the preparation and submittal of closeout documentation. The sponsor or grant administrator should establish that the time of performance for this deliverable is 90 days from project acceptance.

To facilitate tracking the status of this deliverable, it is recommended that a specific payment provision based on a reasonable lump sum is stipulated as opposed to including this work as part of a cost-plus fixed fee of the construction observation services. Consultant agreements that combine construction observation services and project closeout services create a situation where the project closeout task may be forgotten or overlooked. This situation can result in delays to the closeout of the project grant. Make sure that all closeout procedures are included.

When a consultant is hired to assist with any of the program management activities, the sponsor or grant administrator is required to comply with the requirements listed on the Selection of Consultants assurance form. See Appendix E, Exhibit 2, Selection of Consultants, for further information.

12.3.3 Reporting Schedule

Establishing a reporting schedule is a key component of the reporting and closeout plan. Working with the regional ADO and designated representative to discuss reporting timelines is critical to maintaining open lines of communication and identifying in advance any potential issues that may arise. Under 49 CFR 18.40, a grantee is required to submit a performance report for each fiscal quarter. This report must be submitted within 30 days of the end of the reporting period.

12.3.4 Reporting Tools

SIPs and their associated reporting and closeout activities generate a tremendous volume of hard copy files. It is not unusual for a single construction contract consisting of 25 to 30 homes to generate paper files that are an estimated 7-ft to 10-ft tall. Program tracking systems, such as case management systems (CMS) and document management systems (DMS), have become an integral part of SIPs (see Figure 12.1).

It is necessary to identify and attempt to contact all property owners eligible for participation in an SIP; the CMS/DMS is instrumental in ensuring that all contact attempts can be documented. In some states, tracking and documentation of good-faith efforts to contact eligible property owners is required.

Airports that have established or are considering establishing an SIP must also have an NCP in place as an element of their Part 150 study. The NCP identifies an estimated number of noise-affected parcels and population density. The Part 150 study consultant team generally uses county assessor's information to calculate these estimates. However, it is not sufficient for SIPs to rely on county assessor's information; an existing land use survey should be conducted

Financial
NMP Home > Financial > Financial

Group	Design Cost	CM Service Cost	CO Insp. Service Cost	Entered By	Entered Date	Action
Pilot	\$25,000.00	\$12,000.00	\$6,000.00	smacoglu	7/6/2011	[Edit] [Delete]
Group A	\$40,000.00	\$24,000.00	\$8,000.00	smacoglu	7/6/2011	[Edit] [Delete]
Group A.1	\$40,000.00	\$24,000.00	\$8,000.00	smacoglu	7/6/2011	[Edit] [Delete]
Group A.2	\$40,000.00	\$24,000.00	\$8,000.00	smacoglu	9/22/2011	[Edit] [Delete]
Group A.3						[Edit] [Delete]
Group A.4						[Edit] [Delete]
Group B						[Edit] [Delete]
Group B.1						[Edit] [Delete]
Group B.2						[Edit] [Delete]
Group B.3						[Edit] [Delete]
Group B.4				smacoglu	7/6/2011	[Edit] [Delete]
Decline						[Edit] [Delete]
Deferred	\$8,500.00			hchu	9/22/2011	[Edit] [Delete]
No Response						[Edit] [Delete]
AE						[Edit] [Delete]

Financial Info

Design Cost Constr. Manager Service Cost

CO Inspection Service Cost

Current Property
NMP Home > Current Property > Construction > Pay. App.

Status	Bid	Acoustic	RFI	PCO	CO	Insp.	D. Log	P. List	Pay. App.
Pay App #1	6/6/2011	5/2/2011- 5/27/2011	\$12,000.00	smacoglu					
Pay App #2	7/6/2011	6/6/2011- 6/30/2011	\$45,000.00	smacoglu					
Pay App #3	8/3/2011	7/4/2011- 7/29/2011	\$24,000.00	smacoglu					

Add a new entry...

Payment Application

Payment App. Payment Date

Period From Period To

Due Amount

Comments
Design Survey
Public Outreach, Meetings
Field Office Set Up

Images Courtesy of Psomas.

Figure 12.1. Screenshots of case management and document management systems.

to identify the number of noise-affected parcels. Using the mapping and data collection features of the CMS can assist in identifying all eligible properties. The existing land use survey can be conducted without the use of a CMS, but it is very labor intensive and subject to error and additional scrutiny. To maximize the benefits of a CMS, be sure to provide adequate training for all users of the program.

The basic requirements and features of a program tracking system are that the system:

- Must track program costs,
- Must track eligible FAA reimbursable expenses,
- Must identify eligible and non-eligible parcels,
- Must identify all participating and non-participating property owners,
- Should ideally be web-based,
- Must be inclusive of program database,
- Must provide parcel mapping,
- Must archive all program files in searchable format,
- Must have the ability to track users and user rights, and
- Must be hosted in a secure environment.

12.4 Grant Closeout

The closeout of a grant is the process by which the regional ADO and the project sponsor or grant administrator perform the necessary final administrative and financial actions to complete all requirements set forth in the grant agreement. For SIPs, the closeout process addresses three areas: project work completion, administrative requirements, and financial requirements. The grant closeout documents and reports that may be required for each area are:

Project Work Completion

- As-built plans.
- Updated property map.
- Final construction project closeout report.

Administrative Requirements

- Final outlay report (SF-271).
- Summary of DBE use.
- Property accountability.
- Submittal of federal assurances.

Financial Requirements

- Final project cost summary.
- Block grants.
- Excess payments.
- Fiscal adjustments.

Section 12.4.2 discusses these documents and reports.

The goal of the FAA is to close out active grants as quickly as possible or within the allowable grant period of use (typically 3 years from acceptance). It is important that all parties involved fulfill these requirements promptly so that unnecessary delays in closing a grant can be avoided. Once all work is complete per the approved plans and specifications and the final inspection results in a recommendation of project acceptance, the sponsor or grant administrator must proceed with finalizing all project costs and assembling the required closeout documentation in a timely manner.

12.4.1 Timely Submittal of Closeout Documentation

By entering into a grant agreement, a sponsor or grant administrator agrees to a grant condition that requires it to carry out and complete the project without undue delay. Completion of the project does not end with the physical completion of the work; project completion includes satisfying the requirements for administrative and financial closeout of the grant.

Sound insulation is a program containing multiple projects. Therefore, a single grant may be used to fund multiple construction contracts. If the grant application is for more than one project, use the end date of the project with the longest construction period to determine the deadline to collect the required submittals to finalize the grant closeout. All projects listed under this grant must have completed all the general closeout requirements in order to submit a summarized report. The sponsor should strive to submit all final closeout documentation to the regional ADO within 90 days of the final acceptance from the contractor. The regional ADO will consider extensions to this time limit if unique circumstances prevent reasonable determination of the final project costs. These circumstances can include mitigating contractual issues or resolving disputes regarding the final construction pay estimate.

If for some reason there is a delay in closing an active grant beyond the required time period, consult with the regional ADO as soon as possible. If the project is being managed by a staff scheduler, it is important to keep the staff scheduler informed if there are significant issues that will affect the schedule in order to allow adequate time to advise the regional ADO of a potential delay. Program sponsors should notify the regional ADO of any potential delays that may hinder a project from hitting the target closeout date.

12.4.2 Final Project Closeout Report

The necessary closeout documentation can vary depending on the type and size of the project. Typically, a sponsor or grant administrator must submit the items listed in the following to formally close out an AIP grant project. Sponsors or grant administrators may omit some items if they are not relevant to the specific project. It should be noted that the sponsor may be required to submit some documentation (e.g., commissioning data) before finalizing closeout of the project.

A project sponsor or grant administrator should consult with the ADO to determine what closeout items are necessary based on the type and size of the project and when each submittal is required. It should be noted that the regional ADO reserves the right to request additional information consistent with the approved collection of information for the AIP grant.

A. As-Built Plans

As part of closeout, as-built plans for airport projects involving construction must be submitted. For SIPs, the as-built plans are plans showing the retrofit treatments specified for each home, church, or school that is noise insulated. At the ADO's discretion, certification from the sponsor or grant administrator that as-built plans have been received and will be retained for future use may be accepted. Another option, at the discretion of the ADO, is to accept an electronic version of the as-built plans. The sponsor or grant administrator's project manager must request and retain a set of as-built project drawings for future reference; however, the actual submittal of the record drawings to the regional ADO is not necessary unless specifically requested by the FAA project manager. Projects that include work on FAA facilities may require submittal of record drawings to the regional ADO at the conclusion of the project. The FAA project manager should be consulted to determine whether record drawings should be sent to the regional ADO.

B. Updated Property Map

As part of the adopted Part 150 study, a property map is included. The map shows the noise-affected areas and proposed boundaries for sound insulation. Updating the airport land use plan, if

any changes are made, is needed to illustrate project accomplishments. An FAA Exhibit A property map (FAA Order 5190.6B, *FAA Airport Compliance Manual*) records all interests in land maintained by the airport. Interests in land will include avigation easements secured as part of SIPs.

See Appendix E, Exhibit 3 for a sample property map.

C. Final Construction Project Closeout Report

The sponsor or grant administrator must prepare and submit a final construction report that provides an appropriate and accurate record of the project. The format and extent of this report will vary depending on the type and size of the project. The FAA project manager should be consulted with questions regarding what items need to be addressed in the final report. See Appendix E, Exhibit 4, Project Closeout Report for further information.

At a minimum, unless otherwise approved by the FAA project manager, the report must address or contain the following items:

Project Summary

- Include in the summary the location of the airport, grant agreement date, and amount of any grant amendments that may have been granted.
- Brief narrative of work accomplished. Include explanation for any deleted work item and description of non-participating work item.
- Summary of key milestone dates for receipt of bids, notices to proceed, substantial completion, contract date, final inspection, and final acceptance.
- Final acoustical engineer's report.
- Contract time, including an explanation of liquidated damages (if required) and justification for weather delays (calendar contracts require submittal of National Weather Service data to justify weather events in excess of the normal monthly events).

Executive Summary

- Include a brief summary of activities and compliance with federal assurances.
- Program budget, describing program budget and expenses.
- Historic properties, describing any Section 106 activities and related construction to historic properties.
- Land use compatibility – a list of statistics that summarize sound mitigation efforts and compatible land uses.
- Labor provisions – a statement of compliance with contract labor provisions (payroll reviews, complaints, and so forth). Reference AC 150/5100-6 for more information. Also include a summary of any complaints/findings and how they were resolved.
- Administrative costs, briefly explaining claimed costs. Refer to Section 310.c of FAA Order 5100.38C for eligibility provisions.
- Engineering costs, briefly explaining claimed costs and delineating eligible and ineligible costs.
- Force account. Identify the FAA approval date, provide a listing of claimed costs, provide supporting documentation if not already submitted with drawdown documentation, and include claims for wages and salaries (which must comply with OMB A-87 requirements and may not be arbitrary or prorated). Sponsors and grant administrators may not claim indirect costs unless they have a prior-approved cost allocation plan.
- Construction costs. Summarize final contract quantities, delineate eligible and ineligible costs, identify added or deleted work items, and explain/justify underruns and overruns. Include a summary of change order and supplemental agreements.
- Buy American provisions. Provide the sponsor's or grant administrator's statement addressing whether the contractor complied with Buy American provisions and how the sponsor or grant administrator verified compliance. The sponsor or grant administrator must maintain documentation that supports contractor compliance with Buy American provisions. Upon request of the

FAA project manager, the sponsor or grant administrator must provide this documentation to the FAA as part of the closeout documentation. At a minimum, the sponsor or grant administrator must maintain product information sheets and a shop drawing submittal log or summary table.

Project Cost Summary

- List all costs as described and a brief explanation.

Partial Payment History Summary

- Provide an explanation and financial backup for all payments requested for grant reimbursement leading to final payment.

Change Order Summary

- Provide as part of the financial summary any changes to the budget that were affected by consultant contract amendments.
- All construction change orders should be noted on the project cost summary.

Final Inspection and Punch List Item Clearance

- Provide all inspection and punch list items and reports identified during interim and final inspections.

Mandatory Project Review Comments and Certification Summary

- Completion of checklist is required, as noted on project closeout report (see Appendix E, Exhibit 4).

Disadvantaged Business Enterprise Program Participation Summary

- All sponsors or grant administrators are required, as a condition of project approval, to assume certain DBE obligations as set forth in 49 CFR Parts 23 and 26. Complaints alleging discrimination under the DBE program should be referred to the regional civil rights offices. See *AIP Handbook*, FAA Order 5100.38C, Chapter 14, Section 2 for further information.
- Typically, sound insulation program DBE requirements are part of the overall governing body goal established by the Equal Employment Opportunity (EEO) office. The EEO office will usually fill in the required DBE use forms. In most cases, the SIP manager needs to provide basic information (as illustrated in Appendix E, Exhibit 4, Project Closeout Report).

Final Payment Recommendation and Project Amendment Requirement

- Excess payments. If the final financial report indicates that payments have been made that exceed the federal share of the estimated allowable costs or that the sponsor or grant administrator has received interest on federal funds to which it is not entitled, this amount constitutes a debt to the federal government. The accounting office should be informed of the amount and asked to send a notice to the sponsor or grant administrator that the debt should be paid within 30 days or a charge for interest and penalties in accordance with the Federal Claims Collection Standards will be assessed. [See *AIP Handbook*, FAA Order 5100.38C, Paragraph 1304(b) for guidance regarding offset against another grant.]
- Fiscal adjustments. It may be necessary to make upward or downward adjustments as a result of an audit, grant amendments, or resolution of disputed costs.

D. Final Outlay Report Standard Form SF-271

Per 49 CFR 18.41, grantees must submit a final outlay report indicating all claimed costs under the subject grant. The sponsor's or grant administrator's authorized official must sign this report. The FAA will reject unsigned outlay reports.

See Appendix E, Exhibit 5, Final Outlay Report Form 271 for further information.

E. Property Accountability

A sponsor or grant administrator rarely acquires equipment expressly to carry out a grant for SIPs. However, if a sponsor or grant administrator uses federal funds to acquire equipment to carry out the grant, an inventory of all equipment with a current, per-unit fair market value in excess of \$5,000 must be submitted as part of the closeout package. Equipment no longer needed for airport purposes may be sold or retained by the sponsor or grant administrator. The federal share of the current fair market value must be deducted from the grant amount or reimbursed to the FAA.

F. Submittal of Federal Assurances

Submit the Construction Project Final Acceptance (Appendix E, Exhibit 6), Project Plans and Specifications (Exhibit 7), Equipment Construction Contracts (Exhibit 8), and Real Property Acquisition (Exhibit 9) forms, if applicable.

The sponsor or grant administrator must complete the Construction Project Final Acceptance form and submit to the FAA standard certification attesting to the satisfactory completion of the work in conformance with the approved plans and specifications. Regarding this certification:

- Each certification statement requires the sponsor or grant administrator to indicate a response.
- Negative replies to questions on the certification require an explanation.
- The certification must be signed and dated by an authorized person.

G. Final Project Cost Summary

The sponsor or grant administrator is required to submit a final financial report to the FAA in accordance with 49 CFR 18.41 and 18.50. This report is required even if the sponsor or grant administrator has already received payments equal to the maximum obligation of the United States stated in the grant agreement. For construction and non-construction projects, the final report must be made on the form the sponsor normally uses to request payment (i.e., SF-270 or SF-271 in cases of reimbursement by Treasury check or SF-272 if a letter of credit has been used). The final financial report may also serve as the request for final payment when 100% progress payment has not been made or when an adjustment to the 100% progress payment is required.

See Appendix E, Exhibit 10, Financial Spreadsheet.

H. Block Grants

If the sponsor or grant administrator has used block grant funding to support its SIP, there are additional requirements to be coordinated and complied with the FAA.

12.5 OMB 133 Audit

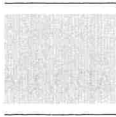
Since most sponsors receive grants from more than one federal agency, cognizant agencies are assigned based on the federal agency that provides the predominate amount of direct funding in accordance with OMB Circular A-133, Audits of States, Local Governments, and Non-profit Organizations.

Grant Assurance #13 (Grant Assurances, Airport Sponsors, Section C, #13 – Accounting System, Audit, and Record Keeping Requirements) and 49 CFR Part 18 require sponsors or grant administrators that expend \$500,000 or more a year in federal funds to conduct a single or program-specific audit for that year in accordance with the Single Audit Act of 1984 (as amended) and OMB Circular A-133. The Single Audit Act of 1984 establishes the procedures to ensure uniformity in the process of conducting audits. This audit is typically not conducted at the same time as the grant closeout.

There are four parties involved with the OMB Circular A-133 process: the FAA ADO, the public sponsor, the sponsor's auditor, and the DOT OIG (if a modal administration in DOT is the cognizant agency). Refer to *AIP Handbook*, FAA Order 5100.38C, Chapter 13, Section 3 for responsibilities.

12.6 Best Practice Recommendations: Project Reporting and Closeout

1. Review the reporting requirements and closeout procedures outlined in *AIP Handbook*, Order 5100.38C, and 49 CFR 18.40. Consult with the regional ADO to verify what submittals are required.
2. Establish ongoing reporting and closeout procedures as part of the SIP's initial work plan. Include specific tasks in the scope of work to clearly identify the FAA reporting timelines and required reports. Consider using a certified workflow process consultant to assist with developing these procedures. Key sponsor decision makers and consultant staff should also participate in the process.
3. Include reporting and closeout responsibilities as a separate task item within consultant agreements, with a separate payment provision for completing this task.
4. Use a program document management and tracking system and ensure that staff are properly trained to use it.
5. Submit all final closeout documentation to the regional ADO within 90 days of the final acceptance from the contractor. If there is a delay in closing an active grant beyond the required time period, consult with the regional ADO as soon as possible.
6. Always consult with the regional ADO regarding any questions on the reporting requirements. Use the FAA as a source of information and direction.



APPENDIX A

Key FAA Documents

Orders

- Order 5190.6B, FAA Airport Compliance Manual, September 30, 2009.
- Order 5050.4B, National Environmental Policy Act (NEPA) Implementing Instructions for Airport Projects, April 2006.
- Order 1050.1E, Change 1, Policies and Procedures for Considering Environmental Impacts, March 20, 2006.
- Order 5100.38C, Airport Improvement Program Handbook, June 28, 2005.

Advisory Circulars

- Advisory Circular 150/5000-9A, Announcement of Availability Report No. DOT/FAA/PP/92-5, Guidelines for the Sound Insulation of Residences Exposed to Aircraft Operations, updated to include complete report, 1993.
- Advisory Circular 150/5000-12, Announcement of Availability – Passenger Facility Charge (PFC) Application (FAA Form 5500-1), 1994.
- Advisory Circular 150/5020-1, Noise Control and Compatibility Planning for Airports, 1983.
- Advisory Circular 150/5050-4, Citizen Participation in Airport Planning, 1975.
- Advisory Circular 150/5100-14D, Architectural, Engineering, and Planning Consultant Services for Airport Grant Projects, 2005.
- Advisory Circular 150/5100-15A, Civil Rights Requirements for the Airport Improvement Program (AIP), 1989.
- Advisory Circular 150/5100-17, Change 6, Land Acquisition and Relocation Assistance for Airport Improvement Program (AIP) Assisted Projects, 2005.
- Advisory Circular 150/5100-6D, Labor Requirements for the Airport Improvement Program (AIP), 1986.
- Advisory Circular 150/5300-9B, Predesign, Prebid, and Preconstruction Conferences for Airport Grant Projects, 2009.

Program Guidance Letters

- Program Guidance Letter 01-2, June 20, 2001.
- Program Guidance Letter 03-02, August 4, 2003.
- Program Guidance Letter 03-02, Attachment A, Evaluation of Noise Set-Aside Portion of the Airport Improvement Program, October 1, 2002.
- Program Guidance Letter 03-02, Attachment B, FY 2003 Noise Set-Aside, October 1, 2002.
- Program Guidance Letter 04-2, April 30, 2004.

Program Guidance Letter 05-4, June 3, 2005.

Program Guidance Letter 05-5, June 1, 2005.

Program Guidance Letter 07-1, June 28, 2005.

Program Guidance Letter 07-1, Attachment 1, Proposed Risk-Based Approach for Oversight of the Airport Improvement Program (AIP) and Standardization of Grant Documentation, June 28, 2005.

Program Guidance Letter 07-1, Attachment 2, National AIP Grant File Index Development, Land, & Planning Projects, June 28, 2005.

Program Guidance Letter 07-02, August 10, 2007.

Program Guidance Letter 07-03, November 20, 2006.

Program Guidance Letter 08-02, February 1, 2008.

Program Guidance Letter 08-06, July 21, 2008.

Program Guidance Letter 10-02, February 24, 2010.

Program Guidance Letter 12-09, August 17, 2012, as amended November 7, 2012.

Other Key Documents

Title 14 CFR Part 150.

FAA Central Region Airports Division, AIP Sponsor Guide, October 1, 2010.

FAA Great Lakes Region Airports Division, Regional Guidance Letter 5100.20, December 12, 2007.



APPENDIX B

Sample Implementation Documents

Sample 1. FAA Sample Avigation Easement.

This sample Avigation Easement is made available to assist Sponsors with the preparation of an agreement for their specific location and situation. We recommend the sponsor furnish this sample to the attorney who will prepare the actual Avigation Easement.

We caution Sponsors that this suggested sample must not be construed as being complete and whole and that the provision of this sample format by the FAA shall not be construed as a guarantee of legal sufficiency. Sponsors are solely responsible for verifying the legal sufficiency of all contractual matters.

SURFACE AND OVERHEAD AVIGATION EASEMENT

WHEREAS, (Property Owner), hereinafter called the Grantors are the fee owners of the following specifically described parcel of land situated in (City, County & State):

(Metes & bounds description of easement parcel)

hereinafter called "Grantors' property" and outlined on an attached Exhibit A map.

NOW, THEREFORE, in consideration of the sum of \$_____ and other good and valuable consideration, the receipt and sufficiency of which is hereby acknowledged, the Grantors, for themselves, their heirs, administrators, executors, successors and assigns do hereby grant the following appurtenant rights and benefits to the (Name of Airport) hereinafter called the "Grantee" for the use and benefit of the public.

The appurtenant rights and benefits include the uses, rights and restrictions described as follows:

The unobstructed use and passage of all types of aircraft in and through the airspace at any height or altitude above the surface of the land.

The right of said aircraft to cause noise, vibrations, fumes, deposits of dust, fuel particles (incidental to the normal operation of aircraft); fear, interference with sleep or communication, and any other effects associated with the normal operation of aircraft taking off, landing or operating in the vicinity of (Airport).

As used herein, the term "aircraft" shall mean any and all types of aircraft, whether now in existence or hereafter manufactured and developed, to include jet, propeller-driven, civil, military or commercial aircraft; helicopters, regardless of existing or future noise levels, for the purpose of transporting persons or property through the air, by whoever owned or operated.

In granting this easement, the Grantors agree to make no modifications to the following "accepted" existing structures lying within the bounds of the easement area of the Grantors' property.

(Example: 20' x 25' utility shed, see attached Exhibit A map)

The Grantors agree that during the life of this easement, they will not construct, erect, suffer to permit or allow any structure or trees on the surface of the burdened property. The Grantors may not permit any places of public assembly or gatherings within the easement area. (Examples: churches, schools, day care facilities, hospitals, restaurants, stadiums, office buildings, etc.) The Grantors are permitted to continue to grow and harvest crops or graze livestock in the easement area

The Grantors agree to keep the easement area free of the following: structures (permanent or temporary) that might create glare or contain misleading lights; residences, fuel handling and storage facilities and smoke generating activities and creation of any means of electrical interference that could effect the movement of aircraft over the easement area.

Grantors agree to waive all damages and claims for damages caused or alleged to be caused by the Grantors violation of any aspect of this easement document. The (Airport) has a perpetual right of ingress/egress in the easement area and the right to remove any new structure or vegetation that is not specifically mentioned above as "accepted."

TO HAVE AND TO HOLD said easement and right of way, and all rights appertaining thereto unto the Grantee, its successors, and assigns, until said (Airport) shall be abandoned and shall cease to be used for public airport purposes. It is understood and agreed that all provisions herein shall run with the land and shall be binding upon the Grantors, their heirs, administrators, executors, successors and assigns until such time that the easement is extinguished.

IN WITNESS WHEREOF, the grantors have hereunto set their hands and seals this _____ day of _____, 20____. (Local recordation and subordination practices must also be met. If subordination is necessary in which case the mortgagee must join in the agreement, a statement must be made to assure that the mortgage is subordinate to the Easement and the Easement recording superior and prior to lien in said mortgage without consideration of the date of the mortgage instrument)

_____(SEAL)
Grantor(s)

Sample 2. SIMS Avigation and Noise Easement.

RECORDING REQUESTED BY:
City of Phoenix

WHEN RECORDED MAIL TO:
Real Estate Division
City of Phoenix
251 W. Washington
8th Floor
Phoenix, Arizona 85003

AVIGATION AND NOISE EASEMENT

The Avigation and Noise Easement (hereinafter "Easement") is made to the City of Phoenix on _____, 2009, by and between _____ (hereinafter "Grantor") and the City of Phoenix (hereinafter "Grantee"), a municipal corporation of the State of Arizona.

RECITALS

1. Grantor owns real property in the City of Phoenix, State of Arizona, which includes the air space above it ("Grantor's Property"). The legal description for Grantor's Property is attached as Exhibit A and is located at «ADDRESS», «CITY» «ZIP», Maricopa County, Arizona.
2. Grantee owns and operates Phoenix Sky Harbor International Airport in Phoenix, Arizona, (the "Airport"). The description for the Airport is attached as Exhibit B.
3. Grantor has been offered the opportunity to participate without cost in Grantee's Sound Insulation Mitigation Services project ("project"). This project will cause improvements to be made to Grantor's Property, in an effort to reduce aircraft noise currently being experienced in the interior of the non-residential building.
4. Grantor understands that the flight operations and the associated effects of the Airport on the surrounding area are pre-existing conditions. Grantor further understands that the flight operations and their associated effects are likely to increase. The Grantee has requested that Grantor ensure that future property owners are aware of and acknowledge the effects of the Airport. This Easement permits the operation of aircraft over Grantor's Property.

NOW, THEREFORE, the parties agree as follows:

Section 1. Easement

A. For valuable consideration, Grantor grants to Grantee a nonexclusive, assignable aviation and noise easement in and over Grantor's Property for noise and other negative impacts resulting from aircraft flying to and from the Airport and other operations at the Airport ("Airport Operations"), and for the free and unrestricted passage of aircraft of any and all kinds now or hereafter known in, through, across and about the airspace beginning at a point two hundred (200) feet above the surface of Grantor's Property. This Easement specifically permits the imposition of light, smoke, air currents, electronic or other emissions, vibrations, discomfort, inconvenience, and interference with use and enjoyment resulting from Airport Operations producing noise. This Easement is fully effective as of the date set forth above.

B. This Easement includes, but is not limited to:

1. The use and benefit of the public and includes the continuing right to fly, or cause or permit the flight by any and all persons, of aircraft, of any and all kinds now or hereafter known, in, through, across or about any portion of the airspace two hundred (200) feet above Grantor's Property; and
2. The right to cause or create, permit or allow to be caused or created within all space above the existing surface of Grantor's Property and any and all airspace laterally adjacent to Grantor's Property, such noise, vibration, current and other effects of air, illumination and fuel consumption as may be inherent in, or may arise or occur from or during the operation of aircraft of any and all kinds, now or hereafter known or used, for navigation of or flight in air; and
3. The right to mark and light, or cause or require to be marked or lighted, as obstructions to air navigation, any and all buildings, structures or other improvements, and trees or other objects, which extend into or above the airspace; and
4. The right to ingress to, passage within, and egress from the above described Grantor's Property for the purposes described in subparagraph "3" above.

C. Grantor recognizes that the Grantor's Property is currently in the «SZ LDN Cur» DNL Noise Area. This Easement will remain a record on Grantor's Property until such time, if ever, that the Grantor's Property:

a. Is subject to an official noise contour reclassification, in accordance with the Federal Aviation Administration; and

b. The noise has increased to «SZ LDN Inc» DNL Noise Area. If the Grantor's Property is officially reclassified to the «SZ LDN Rec» DNL Noise Area, then this Easement will end and be of no further force or effect.

D. Grantor, on behalf of itself, its successors and assigns, hereby covenants with Grantee and for the direct benefit of the real property constituting the Airport described in Exhibit B as follows:

1. That Grantor, its successors and assigns will not construct, install, permit or allow any building, structure, improvement, tree, or other object on the Grantor's Property described herein, to extend into or above the airspace, or to constitute an obstruction to air navigation, or to obstruct or interfere with the use of the easement herein granted; and

2. That Grantor, its successors and assigns, will not hereafter use or permit the use of Grantor's Property in such a manner as to create electrical or electronic interference with radio communication or radar operation between a Federal Aviation Administration control tower located at the Airport and any aircraft.

E. The Easement herein granted shall be deemed both appurtenant to and for the direct benefit of that real property which constitutes the Airport as described in Exhibit B, and shall further be deemed in gross, being conveyed to the Grantee for the benefit of the Grantee and any and all members of the general public who may use this Easement or derive benefit from the taking off from, landing upon or operating such aircraft in or about the Airport, or in otherwise flying through the airspace over Grantor's Property.

F. This Easement does not authorize the Grantee or any other person to cause or impact or deposit upon the Grantor's Property physical objects of any type that are a part of, or are carried in or upon aircraft operating to and from the Airport.

G. This Easement shall not operate to deprive the Grantor, its successors or assigns, of any rights, which it may from time to time have against any air carrier or private operator for negligent or unlawful operation of aircraft.

H. These covenants and Easement run with the land and are binding upon the heirs, administrators, executors, successors and assigns of the Grantor.

Section 2. Release

Grantor releases Grantee, Airport operators and aircraft operators using the Airport from any claims, losses, liabilities or expenses (collectively, "Losses") arising from the impositions permitted by this Easement, as well as from noise and other negative impacts. Grantor shall not sue for damages in connection with Losses released by this Easement, nor seek to enjoin the impositions permitted by this Easement. This release does not affect any rights of Grantor to pursue separately any claims it may have against an air carrier or private operator for negligent or unlawful operations of aircraft.

Section 3. Continuous Benefits and Burdens

This Easement burdens the Grantor's Property for the benefit of the Airport. It runs with the land under Arizona Law. The benefits and burdens created by this instrument apply to and bind the parties' successor, heirs and assigns.

Section 4. Recordation

The City of Phoenix shall record this document in the Official Records of Maricopa County.

GRANTOR:

By: _____
Property Owner

[Insert Title:] _____

By: _____
Property Owner

[Insert Title:] _____

GRANTEE:

CITY OF PHOENIX, a municipal corporation
DAVID CAVAZOS, City Manager

By: _____
Danny W. Murphy
Aviation Director

ATTEST:

City Clerk

APPROVED AS TO FORM:

Acting City Attorney

STATE OF ARIZONA)
) ss.
County of Maricopa)

On this _____ day of _____, 20____, before me, the undersigned Notary Public in and for the State of Arizona, duly commissioned and sworn, personally appeared:

known to me to be the individual(s) described in, and who executed, the above instrument and each acknowledged that he/she/they signed and sealed the same with his/her/their free and voluntary act and deed for the uses and purposes herein mentioned.

IN WITNESS WHEREOF, I hereunto set my hand and affixed my official seal the day and year first above-written.

Notary Public

My commission expires:

URLs for More Sample Avigation Easements

<http://www.dot.ca.gov/hq/planning/aeronaut/documents/ALUP/CT%20ALUPH%20Appendix%20D.pdf>
<http://www.clevelandsound.com/pdf/SampleAvigationEasement.pdf>
<http://www.prcity.com/government/departments/publicworks/airport/pdf/AvigationEasement.pdf>
http://www.quieterhome.org/documents/sample_easement.pdf
<http://www.bradleyairport.com/Community/images/Easement.pdf>
http://www.jeffco.us/jeffco/airport_uploads/10_Appendix_B___Sample_Avigation_Easement.pdf
http://www.yourfreelegalforms.com/item_1009/Aviation-Easement-and-Right-of-Way-at-Airport.html

Sample 3. SIMS Program Application.



**PROGRAM PARTICIPATION
APPLICATION**

ELIGIBILITY STATUS IDENTIFICATION

Thank you for your interest in Phoenix Sky Harbor International Airport's (PSHIA) Sound Insulation Mitigation Services (SIMS).

Before being offered a participation application and a program agreement packet, please take a moment and answer the following questions to aid us in determining your eligibility for SIMS.

1. How is property owned?
Individual ☐ Corporation ☐
2. Do you own the property you wish to have sound mitigated, or do you legally represent the current owner of the property?
Yes ☐ No ☐
3. If your property has multiple owners, are all of the owners willing to participate and sign the necessary documents required to participate in SIMS?
Yes ☐ No ☐
4. Was your property built before October 1, 1998?
Yes ☐ No ☐

If you answered "no" to any of the questions above, please do not fill out the program participation application and program agreement at this time. You may not be eligible for SIMS. Please call 602-261-7950 to speak with one of our SIMS Property Owner Representatives.

If you answered "yes" to the questions above, you may proceed with completing the following packet.



Community Noise Reduction Program
Sound Insulation Mitigation Services
S I M S

Sound Insulation Mitigation Services (SIMS) is offered through Phoenix Sky Harbor International Airport's (PSHIA) Community Noise Reduction Program. SIMS provides acoustical building treatments to eligible nonresidential structures that were identified in PSHIA's Nonresidential Sound Mitigation Services Feasibility Study conducted in 2006. SIMS is available to eligible schools, places of worship and community centers built before October 1, 1998 in the Cities of Phoenix and Tempe, and located within a 1999 noise contour approved in the Federal Aviation Regulation Part 150 Noise Compatibility Study for PSHIA.

Participation in SIMS is voluntary. The SIMS Team has determined that your property is located within the eligible noise contour and therefore may be eligible for sound mitigation. The information requested in this application will help determine eligibility and provide pertinent information necessary to sound mitigate your property.



Community Noise Reduction Program
Sound Insulation Mitigation Services
S I M S

SOUND INSULATION MITIGATION SERVICES PROGRAM
PARTICIPATION APPLICATION

If you are interested in sound mitigating your property and participating in the Phoenix Sky Harbor International Airport's (PSHIA) Sound Insulation Mitigation Services (SIMS) offered by the City of Phoenix please complete this application.

Only property owners may submit a packet.

COMPLETE ALL APPLICABLE SECTIONS OF THE PACKET TO THE BEST OF YOUR ABILITY BEFORE SUBMITTAL. IF YOU HAVE A COPY OF YOUR CURRENT DEED, YOU MAY ATTACH IT ALONG WITH THIS PACKET. PLEASE DO NOT ATTACH ANY ORIGINAL DOCUMENTS. PRINT ALL RESPONSES CLEARLY. IF NECESSARY, YOU MAY ATTACH A SEPARATE PIECE OF PAPER IF YOU NEED ADDITIONAL ROOM TO COMPLETE THE SECTIONS.

SHOULD YOU NEED ASSISTANCE IN COMPLETING YOUR PACKET, PLEASE CALL 602-261-7950 AND ASK TO SPEAK TO A SIMS PROPERTY OWNER REPRESENTATIVE.

WHEN FINISHED, RETURN YOUR PACKET TO:

Sound Insulation Mitigation Services (SIMS)
 C/O CSDA Architects, Inc.
 432 North 44th Street, Suite 120
 Phoenix, AZ 85008

The SIMS office is open Monday-Friday 8 a.m.-5 p.m. We encourage you to drop your packet off in person. If you choose to return your packet by mail, please contact us if you do not receive an acknowledgment of receipt within two weeks. You may also schedule a "pick up" for your packet by calling our offices at the number listed above.

The information you provide will be kept confidential to the full extent provided by law and will only be used by appropriate SIMS personnel.

***** Office Use Only *****

Date Received: _____ Time Received: _____ Received By: _____

Completed by Property Owner Representative: Yes ☐ No ☐ Received Receipt: Yes ☐ No ☐

In Person ☐ By Mail ☐ Date Mailed:

-	-	-	-	-	-

 Initials: _____

Last Name: _____ APN:

-	-	-	-	-	-	-	-	-	-

 DNL:

-	-	-	-	-	-

Information Entered on GIS: Yes ☐ No ☐

Project File Created: Yes ☐ No ☐

I. PROPERTY INFORMATION

1. Eligible Property Address:

_____ State: _____ Zip Code: _____

2. Are you aware of any title issues with your property? Yes ☐ No ☐

3. If you answered "yes" to question 2, please explain the nature of the title issue(s).

4. Are any of the property owners deceased? Yes ☐ No ☐

5. If you answered "yes" to question 4, has the property completed probate? (Probate is the judicial determination of the validity of a will. Probate also refers to the general administering of a deceased person's will or the estate of a deceased person without a will.) Yes ☐ No ☐

6. Do you currently have tenants occupying the property address? Yes ☐ No ☐



II. APPLICANT/OWNER INFORMATION

"Applicant" is the property owner or authorized representative who will work most closely with the SIMS Property Owner Representative and who will provide most of the information necessary to participate in SIMS.

PLEASE PROVIDE YOUR FULL LEGAL NAME BELOW:

Last Name:

First Name:

Middle Name (s):

Address: State: Zip Code:

CONTACT NUMBERS:

Home: Best time to call: Morning ☐ Afternoon ☐ Evening ☐

Work: Best time to call: Morning ☐ Afternoon ☐ Evening ☐

Cell: Best time to call: Morning ☐ Afternoon ☐ Evening ☐

Other: Best time to call: Morning ☐ Afternoon ☐ Evening ☐

Email Address:

Preferred Language: Written Spoken

Date of Property Purchase:

Please check if you are: Property Owner ☐ Authorized Representative ☐

IF YOU ARE AN AUTHORIZED REPRESENTATIVE, PLEASE ATTACH TO THIS APPLICATION, A SIGNED, DATED AND NOTARIZED AUTHORIZATION FORM (BOARD RESOLUTION, LETTER AUTHORIZING ATTORNEY OR POWER OF ATTORNEY) FROM PROPERTY OWNER.

PLEASE COMPLETE THE FOLLOWING SECTION FOR ALL PROPERTY OWNERS.

Please attach a separate piece of paper if there are more than four owners.

A. Full Legal Name as it appears on the property title or deed:

Last Name: _____

First Name: _____

Middle Name (s): _____

Address: _____ State: _____ Zip Code: _____

CONTACT NUMBERS:

Home: _____ Best time to call: Morning ☐ Afternoon ☐ Evening ☐

Work: _____ Best time to call: Morning ☐ Afternoon ☐ Evening ☐

Cell: _____ Best time to call: Morning ☐ Afternoon ☐ Evening ☐

Other: _____ Best time to call: Morning ☐ Afternoon ☐ Evening ☐

Email Address: _____

Preferred Language: Written _____ Spoken _____

B. Full Legal Name as it appears on the property title or deed:

Last Name: _____

First Name: _____

Middle Name (s): _____

Address: _____ State: _____ Zip Code: _____

CONTACT NUMBERS:

Home: _____ Best time to call: Morning ☐ Afternoon ☐ Evening ☐

Work: _____ Best time to call: Morning ☐ Afternoon ☐ Evening ☐

Cell: - - Best time to call: Morning ☐ Afternoon ☐ Evening ☐

Other: - - Best time to call: Morning ☐ Afternoon ☐ Evening ☐

Email Address:

Preferred Language: Written _____ Spoken _____

C. Full Legal Name as it appears on the property title or deed:

Last Name:

First Name:

Middle Name (s):

Address: State: Zip Code:

CONTACT NUMBERS:

Home: - - Best time to call: Morning ☐ Afternoon ☐ Evening ☐

Work: - - Best time to call: Morning ☐ Afternoon ☐ Evening ☐

Cell: - - Best time to call: Morning ☐ Afternoon ☐ Evening ☐

Other: - - Best time to call: Morning ☐ Afternoon ☐ Evening ☐

Email Address:

Preferred Language: Written _____ Spoken _____

D. Full Legal Name as it appears on the property title or deed:

Last Name:

First Name:

Middle Name (s):

Address: State: Zip Code:

CONTACT NUMBERS:

Home: - - Best time to call: Morning ☐ Afternoon ☐ Evening ☐

Work: - - Best time to call: Morning ☐ Afternoon ☐ Evening ☐

Cell: - - Best time to call: Morning ☐ Afternoon ☐ Evening ☐

Other: - - Best time to call: Morning ☐ Afternoon ☐ Evening ☐

Email Address:

Preferred Language: Written _____ Spoken _____

If you wish to designate a separate party to be the Authorized Representative during your involvement in the SIMS program, please list his/her name and contact information:

Last Name:

First Name:

Address: State: Zip Code:

Relationship to Applicant: _____

CONTACT NUMBERS:

Home: - - Best time to call: Morning ☐ Afternoon ☐ Evening ☐

Work: - - Best time to call: Morning ☐ Afternoon ☐ Evening ☐

Cell: - - Best time to call: Morning ☐ Afternoon ☐ Evening ☐

Other: - - Best time to call: Morning ☐ Afternoon ☐ Evening ☐

Email Address:

Preferred Language: Written _____ Spoken _____

A signed, dated and notarized authorization of representative by property owner will be required prior to SIMS program proceeding with contact to Authorized Representative. Please attach authorization form to this document.

III. TENANT OCCUPANCY INFORMATION

If the property is tenant occupied, please list all occupants below. (Please attach a separate piece of paper if you need extra space).

Main Tenant Contact	Last Name	First Name	Contact Number	Total Number of Tenants in Unit

IV. Intent to Participate

BY SIGNING BELOW, THE APPLICANT AGREES HE/SHE/IT INTENDS TO MOVE FORWARD WITH THE SIMS PROGRAM. THIS REQUIRES OBTAINING OWNER SIGNATURES FOR THE PARTICIPATION AGREEMENT AND AVIGATION EASEMENT, ALLOWING ACCESS TO THE PROPERTY BY SIMS TEAM MEMBERS WHEN REQUIRED FOR PROGRAM PURPOSES, AND PROVIDING ANY ADDITIONAL INFORMATION THAT MAY BE REQUIRED TO MOVE YOUR PROPERTY FORWARD IN THE SIMS PROGRAM.

I (WE) CERTIFY THAT THE ABOVE INFORMATION IS CORRECT TO THE BEST OF MY (OUR) KNOWLEDGE AND BELIEF.

Owner(s) Signature:

Signature: _____ Date ____/____/____

Printed Name: _____

Signature: _____ Date ____/____/____

Printed Name: _____

Signature: _____ Date ____/____/____

Printed Name: _____

Signature: _____ Date ____/____/____

Printed Name: _____

Signature: _____ Date ____/____/____

Printed Name: _____

Sample 4. SIMS Participation Agreement.

File No: CSDA-

CITY OF PHOENIX AVIATION DEPARTMENT
COMMUNITY NOISE REDUCTION PROGRAM
SOUND INSULATION MITIGATION SERVICES

PROPERTY OWNER(S) PARTICIPATION AGREEMENT

between

CITY OF PHOENIX, a municipal corporation of Arizona

and

[Insert property name]

City of Phoenix Aviation Department
Phoenix Sky Harbor International Airport
3400 E. Sky Harbor Boulevard
Phoenix, AZ 85034-4405
(602) 273-4300

**CITY OF PHOENIX AVIATION DEPARTMENT
SOUND INSULATION MITIGATION SERVICES**

PROPERTY OWNER(S) PARTICIPATION AGREEMENT

THIS PROPERTY OWNER(S) PARTICIPATION AGREEMENT ("Agreement") is made and entered to this 7th day of January, 2010 ("Effective Date") between the CITY OF PHOENIX, a municipal corporation of Arizona ("City"), and [Insert property name], ("Property owner(s)") and is made effective as of the last date below.

RECITALS

1. City is the owner and operator of Phoenix Sky Harbor International Airport. City Aviation Department has undertaken a Sound Insulation Mitigation Services Project ("Project") to reduce aircraft-generated noise levels penetrating eligible non-residential structures in the vicinity of Phoenix Sky Harbor International Airport ("Airport").
2. Property owner(s) is/are the owner(s) of property located at [Insert property address] (the "Property"). Property owner(s) is/are hereby notified of its/their eligibility to participate in the Project as the owner(s) of a non-residential structure to be sound mitigated by City.

NOW, THEREFORE, Property owner(s) and City agree as follows:

AGREEMENT

1. PURPOSE

The purpose of City's Project, is to reduce interior noise levels from aircraft departures and arrivals for eligible non-residential structures. This Agreement sets forth the understanding between City and Property owner(s) regarding work to be done, access to the Property by the Project staff, its consultants, and contractors, and the duties and responsibilities of City and Property owner(s).

2. PROPERTY

Property owner(s) holds legal title to the real property and improvements located at [Insert property address], and is described in Exhibit "A". If the Property serves as security for money loaned, Property owner(s) shall obtain from the Lender written permission to have the work performed by the City and to grant to the City the Aviation and Noise Easement. If Property owner(s) is/are interested in granting authorization, Project staff will contact the Property

owner(s) Lender with regard to the permission requirements to allow Project work to be performed. City reserves the right to not undertake the work until the City Aviation Department is satisfied that Property owner(s) can grant and convey a valid and enforceable Avigation and Noise Easement.

[Check below if applicable]

☐ I/we am/are the Property owner(s) and I/we am/are informed that public records disclose that the Property serves as security for a mortgage or Deed of Trust. I/we have been advised to obtain the consent of the Lender before executing the Avigation and Noise Easement. I am advised and understand that the granting of the Avigation and Noise Easement without obtaining the Lender's consent could cause the Lender to take legal action to recover the entire amount of the loan then outstanding. I/we am/are further advised that my failure to obtain the Lender's consent before _____ may cause City to delay sound mitigation to the Property until the Lender's consent is obtained.

3. TERM

This Agreement shall commence on the Effective Date and shall continue in full force and effect until completion of the Scope of Work unless terminated by the City or Property owner(s), subject to any restrictions or conditions imposed by this Agreement.

4. SCOPE OF WORK

A. The Property owner(s)'s will be asked to review and approve a Scope of Work that shall become a part of this Agreement and at that time, this Agreement will be amended to include the approved Scope of Work as Exhibit B.

B. Property owner(s) will carefully review the Scope of Work concerning the specific sound mitigation work to be completed at the Property. Property owner(s) must agree to accept the work as described and agree(s) to abide by the Project policies as follows:

1. All work will be performed by selected, qualified, and licensed general contractor(s) under contract with the City.
2. All work will conform to standard industry practices and quality workmanship. The Project staff shall be responsible for overseeing the work of the contractor(s), and shall be responsible for all inspections for quality of work and quality of materials where possible.
3. All sound mitigation materials shall become the property of Property owner(s) upon completion of the work and final inspection and acceptance by Property owner(s) and the Project Staff.
4. After final inspection and acceptance of the work by Property owner(s) and Project staff, Property owner(s) is/are responsible for general maintenance of sound improvements and replacement of sound mitigation improvements after expiration of the manufacturers'

warranties.

5. ACCESS TO PROPERTY

A. Property owner(s) agree(s) to allow the Project staff and its consultants or contractors access to the Property at reasonable times to conduct existing conditions surveys and to perform noise measurements before and after construction, if applicable, to determine appropriate sound mitigation methods, and to perform tests for the presence of asbestos, lead paint, and other hazardous materials that could affect construction. Property owner(s) will allow access to the Property to contractors to perform the agreed upon Scope of Work.

B. Project staff shall keep Property owner(s) informed of the overall Project schedule so that disruptions to Property owner(s)'s business or routines will be kept to a minimum, and shall contact Property owner(s) at least 48 hours in advance of visits to arrange for an appointment.

C. Property owner(s) agree(s) to be present at all times when the Project staff or contractors visit the Property. Property owner(s) may designate an agent to act on Property owner(s)'s behalf. When Property owner(s) designate(s) an agent to be present at a site visit, inspection, or during construction, Property owner(s) must sign a release form naming the designated person(s) and submit the release form to the Project staff twenty-four (24) hours prior to the scheduled event to be attended by the designated agent.

D. Project staff will notify Property owner(s) in advance of the start date of construction work on the Property and will work to accommodate Property owner(s)'s schedule within the estimated construction period.

E. During the construction period, Property owner(s) agree(s) to be responsible for moving and/or removing items such as furniture, items stored in attic or basement areas, curtains, draperies, furnishings, or securing of fragile items in order to provide the contractors reasonable access to work areas.

F. Property owner(s) further agree(s) to cooperate fully with the Project staff, and the contractors to provide access to the Property prior to and after construction for noise measurements, throughout the construction period, and up to final completion of work and acceptance by Property owner(s) and Project staff. Failure to provide such access may result in termination of work and exclusion from the Project.

G. Property owner(s) agree to withhold from doing any construction to or on the Property during the Project's design and/or construction unless this work is approved in advance in writing by a Project representative. Construction work that is done to the property, outside of emergency health and safety items, during the Projects design and/or construction without previous written agreement with the Project representative may result in termination of work or exclusion from the Project.

6. NON-RECOURSE AND INDEMNITY PROVISIONS

A. Property owner(s) agree(s) that if it chooses to withdraw from the Project after reviewing and signing the approved Scope of Work, except for reasons beyond its control, Property owner(s) will reimburse City for direct Project expenditures made on behalf of Property owner(s). In such an event, City shall have no obligation to advance the work after the date that written notice of withdrawal is received from Property owner(s), nor shall City be obligated to restore the Premises to its pre-construction condition.

B. Upon completion of the work and final inspection by Property owner(s) and the Project staff, any subsequent repairs or adjustments to the installed components, material, or workmanship of the contractors or subcontractors shall be under warranty for a period of one (1) year from the date of acceptance of the work by Property owner(s) and Project staff, after which time any necessary repairs or adjustments shall become the responsibility of Property owner(s). Property owner(s) acknowledge(s) that if a defect is detected within any applicable warranty period, it is Property owner(s)'s responsibility to immediately inform the Project staff, in writing. Upon acceptance of the work by Property owner(s) and Project staff, City will provide all manufacturer's warranties and guarantees to Property owner(s).

C. Property owner(s) agree(s) that any claims arising from the manner in which the work was performed by the general contractor causing injury or damages to persons or property shall be made against the general contractor and not against City, and Property owner(s) agree(s) to hold City harmless from any and all such claims.

D. Property owner(s) acknowledge(s) that the Project is funded by federal and local money for sound mitigation of the non-residential structures on the Property. In consideration thereof, Property owner(s) agree(s) to hold harmless City from all liability for all matters relating to sound mitigation design and construction, and Property owner(s) agree(s) to assert no claim, nor bring any action against City pertaining to matters arising from the contract between City and the general contractor. Nothing in this Agreement shall be construed to preclude Property owner(s) from pursuing claims and remedies related to the work against appropriate parties other than City.

E. Property owner(s) releases and holds harmless City from all liability for any actions taken in connection with the Project relating to the identification or abatement of hazardous materials, asbestos or other substances, the rendering of financial assistance in connection with such identification or abatement, or from any occurrence relating to relocation during abatement of hazardous materials, asbestos or other substances.

F. Property owner(s) agree(s) to further indemnify, hold harmless and defend the City, its officials, officers, employees, agents, consultants, boards and commissions, contractors, subcontractors, and suppliers from and against all claims, demands, actions, causes of action, losses, damages, liabilities, costs and expenses including, but not limited to, reasonable attorneys' fees, for or in connection with personal injury, including death, and property damage which arises out of or is in any way connected with any negligent act, error, or omission of Property owner(s) or any person employed by it or anyone whose acts the Property owner(s)

is/are legally liable including, but not limited to, dangerous condition(s) of the Premises.

7. NON-REMOVAL OF SOUND MITIGATION MATERIALS

A. Property owner(s) understands that the purpose of the Project is to sound mitigate non-residential structures to reduce aircraft overflight noise levels. Property owner(s) and tenants, if any, shall not intentionally remove, modify or tamper with any of the sound mitigation materials and equipment installed as part of the Project or take any other actions that reduce or destroy the effectiveness of the sound mitigation treatment for so long as the structure is used as a non-residential structure(s).

B. Property owner(s) acknowledges that during installation of sound mitigation materials and components no modifications or construction by Property owner(s) is allowed except as provided elsewhere in this agreement.

C. Property owner(s) acknowledges that modifications by Property owner(s) to work completed under the Project may result in decreased noise resistance of the non-residential structures on the Property and may void installation, product, and material warranties.

8. SEPARATE AGREEMENTS PROHIBITED

Property owner(s) agrees to not enter into any agreements with the City's general contractor or subcontractor(s), regarding changes to the Scope of Work or for additional work without the express written consent of City. This requirement expires upon acceptance of the work.

9. AVIGATION AND NOISE EASEMENT

In consideration of the foregoing Scope of Work to be performed on Property owner(s)'s non-residential structure(s), Property owner(s) agree(s) to grant and convey to City an Avigation and Noise Easement. The Avigation and Noise Easement shall be executed concurrently with this Agreement. The Avigation and Noise Easement will be recorded by the City in the Office of the County Recorder for Maricopa County, Arizona.

10. ENTIRE AGREEMENT

This Agreement and its attachments constitute the entire agreement between City and Property owner(s), and shall not be changed or modified except in writing duly executed by authorized representative of the parties.

11. COVENANTS RUNNING WITH THE LAND

In consideration of the federal and local funding of the sound mitigation improvements to the non-residential structures on the Property, Property owner(s) specifically agrees that the obligations of Property owner(s) are made and entered into for the benefit of Phoenix Sky Harbor International Airport, as the same is now or may hereafter be legally described in the

public records of the City of Phoenix and Maricopa County, Arizona, and shall be covenants running with the land and shall be binding upon Property owner(s)'s heirs, assigns and successors in interest of any description. Property owner(s) further agrees that this Agreement and the Avigation and Noise Easement may be recorded by the City in the Office of the County Recorder of Maricopa County, Arizona.

12. NOTICES

Any notice, consent, or other communication ("Notice") required or permitted under this Agreement shall be in writing and either delivered in person, sent by facsimile transmission, deposited in the U.S. mail, postage prepaid, registered or certified mail, return receipt requested, or deposited with any commercial air courier or express service addressed as follows:

If intended for City: Sound Insulation Mitigation Services
ATTN: Program Manager
One South 24th Street
Phoenix, AZ 85034-2534

Copy to Project Staff: CSDA, Inc.
432 N. 44th Street
Suite 120
Phoenix, AZ 85008

If intended for Property Owner(s): [Insert property name].

ATT: _____

Notice shall be deemed received at the time it is personally served or, on the day it is sent by facsimile transmission, on the second day after its deposit with any commercial air courier or express service, or, if mailed, ten (10) days after the notice is deposited in the U.S. mail as above provided. Any time period stated in a notice shall be computed from the time the notice is deemed received. Either party may change its mailing address or contact information by notifying the other party as provided in this Section.

13. APPROVALS, CONSENTS, AND NOTICES

All approvals, consents, and Notices called for in this Agreement must be in writing and may not be established by oral testimony.

14. CONFLICTS OF INTEREST

This Agreement may be terminated pursuant to the provisions of A.R.S. §38-511.

15. LAWS OF ARIZONA

This Agreement is governed by the laws of the State of Arizona. Any disputes relating to this Agreement must be resolved in accordance with Arizona law.

16. CANCELLATION BY PROPERTY OWNER(S)

Property owner(s) may cancel this Agreement without incurring any costs, prior to reviewing and signing the approved Scope of Work otherwise the provisions in paragraph 6 will apply.

17. CANCELLATION BY CITY

This Agreement may be cancelled by the City at any time prior to commencement of construction on the non-residential structure on the Property, or in the case of a Force Majeure event, or if federal funding has been halted. "Force Majeure" is defined as any act of God or Nature (including fire, flood, earthquake, storm, hurricane or other natural disaster), war, terrorism, government determination, blockage, embargo, labor dispute/strike, or failure of utility service, or similar occurrence that is of an intensity and duration sufficient to disrupt the normal expectations under this Agreement.

IN WITNESS WHEREOF, this Agreement is duly executed on the day and year first above written, by the parties hereto or their authorized representatives, intending themselves to be legally bound hereby.

CITY OF PHOENIX, a municipal corporation
DAVID CAVAZOS, City Manager

By: _____
Danny W. Murphy
Aviation Director

ATTEST

City Clerk

APPROVED AS TO FORM

Acting City Attorney

PROPERTY OWNER(S)

[Insert property name]

By: _____

Title: _____

Date: _____

By: _____

Title: _____

Date: _____

STATE OF ARIZONA)
County of Maricopa)

On this _____ day of _____, 2010, before me, the undersigned Notary Public in
and for the State of Arizona, duly commissioned and sworn, personally appeared:

known to me to be the individual(s) described in, and who executed, the above instrument and
each acknowledged that he/she/they signed and sealed the same with his/her/their free and
voluntary act and deed for the uses and purposes herein mentioned.

IN WITNESS WHEREOF I have hereunto set my hand and affixed my official seal the
day and year first above-written.

Notary Public

My Commission Expires:

EXHIBIT A
LEGAL DESCRIPTION

[Insert property legal description]





Sample 5. SIMS Satisfaction Survey.

Sound Insulation Mitigation Services (SIMS) team requests your input. Please take a few minutes to answer the questions inside this survey. Thank you in advance for your time.

SIMS

Satisfaction Survey

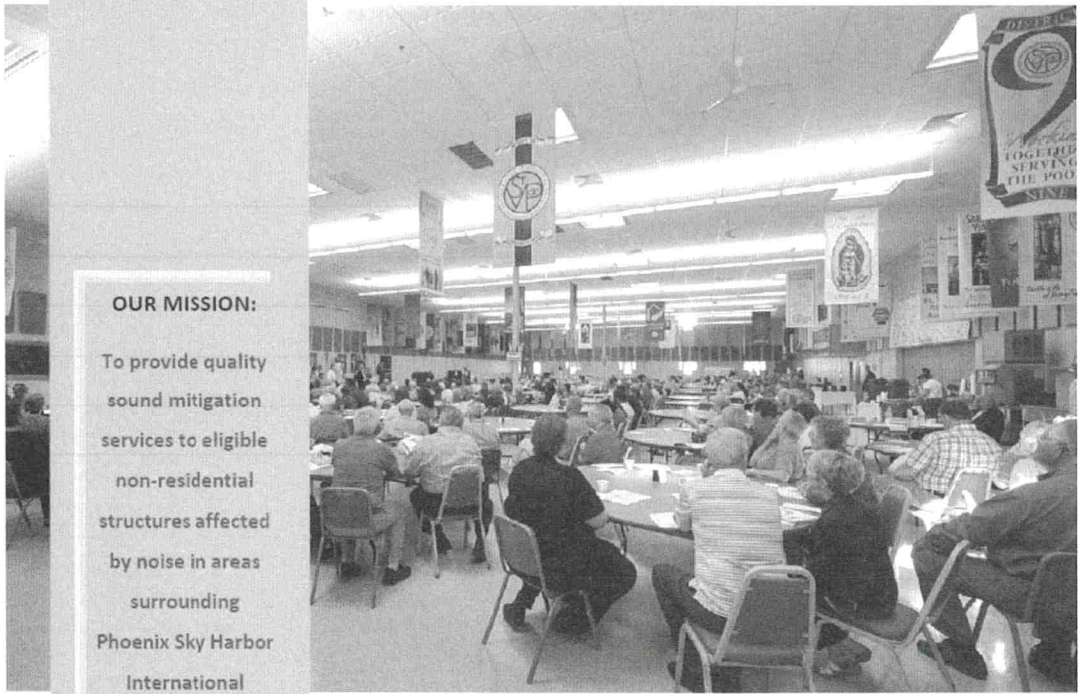
for Society of St. Vincent de Paul








Community Noise Reduction Program
Sound Insulation Mitigation Services
S I M S

OUR MISSION:

To provide quality sound mitigation services to eligible non-residential structures affected by noise in areas surrounding Phoenix Sky Harbor International Airport.



SIMS Satisfaction Survey



Community Noise Reduction Program
Sound Insulation Mitigation Services
S I M S

Name _____

Title _____

Property Address _____

Email _____

Telephone (Work) _____

Telephone (Cell) _____

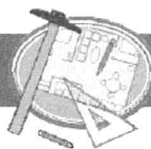


OUTREACH



1. The SIMS Outreach team was helpful in explaining the SIMS program to you, your customers, and/or your Board of Directors.
 Strongly Agree ☐ Agree ☐ No Opinion ☐ Disagree ☐ Strongly Disagree ☐
2. The SIMS Outreach team was easy to contact and helpful in solving any problems.
 Strongly Agree ☐ Agree ☐ No Opinion ☐ Disagree ☐ Strongly Disagree ☐
3. The SIMS Outreach team explained and answered any questions regarding the documents you were asked to sign.
 Strongly Agree ☐ Agree ☐ No Opinion ☐ Disagree ☐ Strongly Disagree ☐
4. Overall, the SIMS Outreach team provided presentations and collateral materials that were useful and informative.
 Strongly Agree ☐ Agree ☐ No Opinion ☐ Disagree ☐ Strongly Disagree ☐

DESIGN



1. The SIMS Design team explained and answered any questions regarding the Design activities at your property.
 Strongly Agree ☐ Agree ☐ No Opinion ☐ Disagree ☐ Strongly Disagree ☐
2. The SIMS Design team was helpful and friendly in solving any problems.
 Strongly Agree ☐ Agree ☐ No Opinion ☐ Disagree ☐ Strongly Disagree ☐
3. During the Design assessment, your property was treated with care.
 Strongly Agree ☐ Agree ☐ No Opinion ☐ Disagree ☐ Strongly Disagree ☐

CONSTRUCTION



1. The SIMS Construction team was courteous and treated your property with respect.
 Strongly Agree ☐ Agree ☐ No Opinion ☐ Disagree ☐ Strongly Disagree ☐
2. The SIMS team was helpful in developing a Construction schedule that worked best with your needs.
 Strongly Agree ☐ Agree ☐ No Opinion ☐ Disagree ☐ Strongly Disagree ☐
3. You were informed of the Construction procedures and understood what was going to happen to your property during construction.
 Strongly Agree ☐ Agree ☐ No Opinion ☐ Disagree ☐ Strongly Disagree ☐
4. You are satisfied with the final results of the installation of new sound insulation materials.
 Strongly Agree ☐ Agree ☐ No Opinion ☐ Disagree ☐ Strongly Disagree ☐

INSPECTION



1. The SIMS Inspection team answered any questions regarding the materials installed in your property.

Strongly Agree ☐ Agree ☐ No Opinion ☐ Disagree ☐ Strongly Disagree ☐

2. The SIMS Inspection team responded in a timely manner and was helpful in solving any problems.

Strongly Agree ☐ Agree ☐ No Opinion ☐ Disagree ☐ Strongly Disagree ☐

3. You are satisfied with the quality of materials and craftsmanship.

Strongly Agree ☐ Agree ☐ No Opinion ☐ Disagree ☐ Strongly Disagree ☐

PROGRAM



1. You have noticed a significant reduction of the sound of aircraft inside your property.

Strongly Agree ☐ Agree ☐ No Opinion ☐ Disagree ☐ Strongly Disagree ☐

2. Others using your property have noticed a significant reduction of the sound of aircraft inside your property.

Strongly Agree ☐ Agree ☐ No Opinion ☐ Disagree ☐ Strongly Disagree ☐

3. Overall, you are satisfied with your participation in the SIMS program.

Strongly Agree ☐ Agree ☐ No Opinion ☐ Disagree ☐ Strongly Disagree ☐

4. You have been given a warranty packet and know who to call if you have any questions or concerns.

Strongly Agree ☐ Agree ☐ No Opinion ☐ Disagree ☐ Strongly Disagree ☐

5. Overall, the program did not affect your business operations or your ability to provide service to your customers.

Strongly Agree ☐ Agree ☐ No Opinion ☐ Disagree ☐ Strongly Disagree ☐

6. Any disruption that affected your business operations or your ability to provide service to your customers was worth the end result.

Strongly Agree ☐ Agree ☐ No Opinion ☐ Disagree ☐ Strongly Disagree ☐

7. How did you hear about the SIMS program?

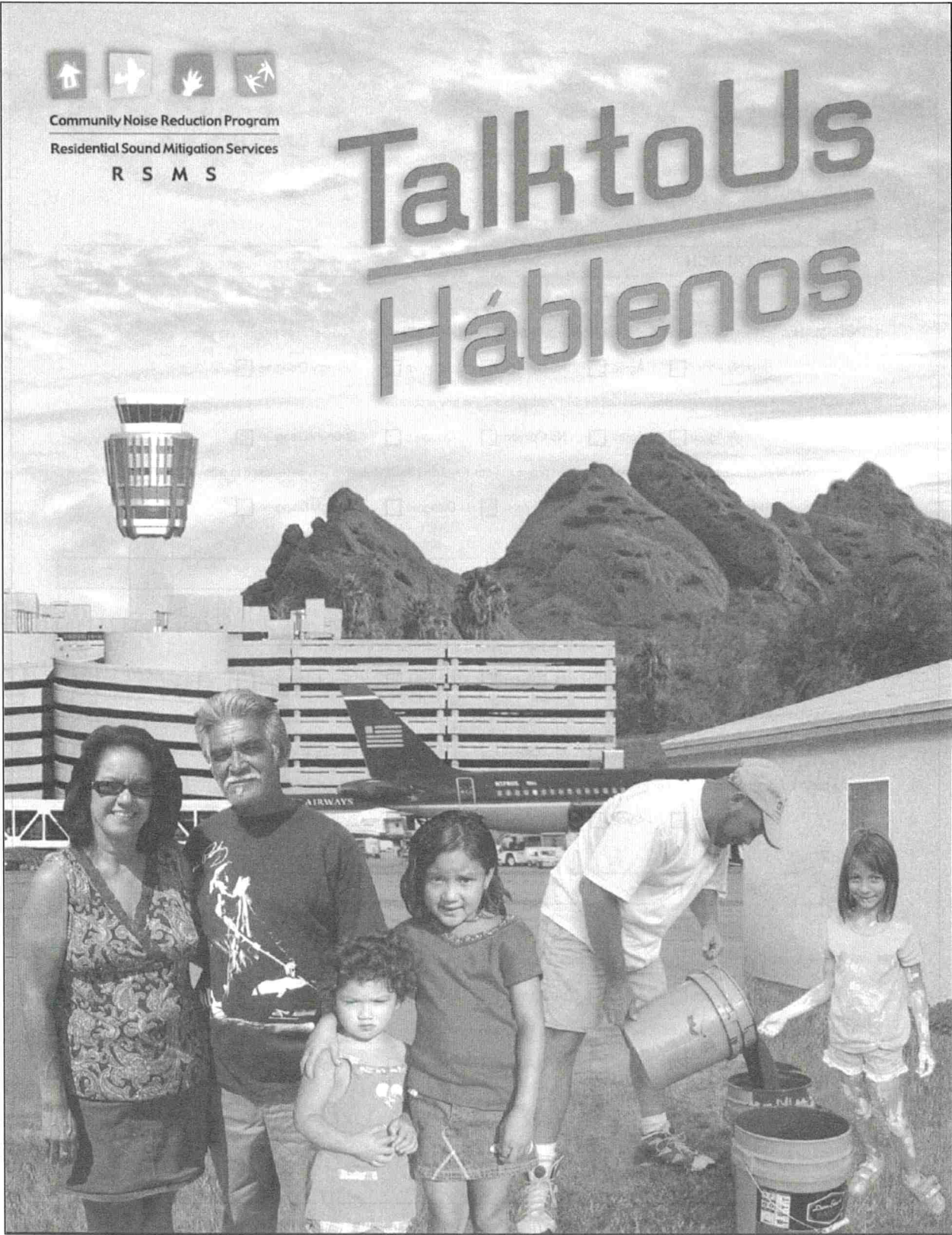
Outreach staff visiting your property ☐ Nearby business ☐ Community Event ☐ Phone ☐ Mail ☐ Other ☐

8. How likely are you to recommend SIMS to others? Likely ☐ Not Likely ☐ Neither ☐

9. What helped you decide to participate?

10. Do you have any additional comments pertaining to the program that you would like to add?

Sample 6. RSMS Satisfaction Survey.



Satisfaction Survey



OUTREACH

1. The RSMS Homeowner Representative was helpful in explaining the Residential Sound Mitigation Services program to you
 Strongly Agree ☐ Agree ☐ No Opinion ☐ Disagree ☐ Strongly Disagree ☐
2. The RSMS Homeowner Representative was helpful and friendly in solving any problems
 Strongly Agree ☐ Agree ☐ No Opinion ☐ Disagree ☐ Strongly Disagree ☐
3. The Homeowner Representative explained and answered any questions regarding the documents you were asked to sign
 Strongly Agree ☐ Agree ☐ No Opinion ☐ Disagree ☐ Strongly Disagree ☐



DESIGN

1. The RSMS Design Staff explained and answered any questions regarding activities during the Design Stage
 Strongly Agree ☐ Agree ☐ No Opinion ☐ Disagree ☐ Strongly Disagree ☐
2. The RSMS Design Staff was helpful and friendly in solving any problems
 Strongly Agree ☐ Agree ☐ No Opinion ☐ Disagree ☐ Strongly Disagree ☐
3. During the Architectural Survey, your property was treated with care
 Strongly Agree ☐ Agree ☐ No Opinion ☐ Disagree ☐ Strongly Disagree ☐



CONSTRUCTION

1. You were informed of the Construction Procedures and understood what was going to happen to your property during construction
 Strongly Agree ☐ Agree ☐ No Opinion ☐ Disagree ☐ Strongly Disagree ☐
2. You are satisfied with the final results of the installation of new sound insulating materials
 Strongly Agree ☐ Agree ☐ No Opinion ☐ Disagree ☐ Strongly Disagree ☐

Satisfaction Survey



INSPECTION

1. The RSMS Quality Control Inspectors answered any questions regarding the materials installed in your home

Strongly Agree ☐ Agree ☐ No Opinion ☐ Disagree ☐ Strongly Disagree ☐

2. You are satisfied with the quality of materials and craftsmanship

Strongly Agree ☐ Agree ☐ No Opinion ☐ Disagree ☐ Strongly Disagree ☐

3. The RSMS Quality Control Inspectors were helpful and friendly in solving any problems

Strongly Agree ☐ Agree ☐ No Opinion ☐ Disagree ☐ Strongly Disagree ☐



PROGRAM

1. You have noticed a significant reduction of the sound of aircraft noise in your home

Strongly Agree ☐ Agree ☐ No Opinion ☐ Disagree ☐ Strongly Disagree ☐

2. Overall, you are satisfied with your participation in the RSMS program

Strongly Agree ☐ Agree ☐ No Opinion ☐ Disagree ☐ Strongly Disagree ☐

3. You have been given your warranty packet and know who to call if you have any questions or concerns

Strongly Agree ☐ Agree ☐ No Opinion ☐ Disagree ☐ Strongly Disagree ☐

Name

Email

Address

Telephone (Home)

Telephone (Cell)

4. How did you hear about the Residential Sound Mitigation Services (RSMS) program

Outreach Staff visiting your home ☐ Neighbor(s) ☐ Phone ☐ Community Event ☐ Mail ☐ Other ☐

5. What helped you decide to participate

6. How likely are you to recommend RSMS to your neighbors

Likely ☐

Neither Likely nor Not Likely ☐

Not Likely ☐

APPENDIX C

Manufacturers' Product Matrixes

Matrix 1. Armaclad Windows and Doors.

ACRP Project 02-24 Guidelines for Airport Sound Insulation Programs					Manufacturers Product Matrix		July 7, 2011	
Company Name: Armaclad Windows & Doors					Product Attributes:			
Location: 6806 Anthony Highway								
PO Box 455								
Mont Alto, PA 17237								
Phone: 800-541-6666								
E-Mail: Mmcshane@sswdws.com								
Product Categories:								
WINDOW PRODUCTS								
Window Product Type:	Material	Performance Rating	STC Range	Historic Applications	WINDOW Categories		MATERIAL Categories:	
					PRODUCT TYPE:			
					Prime or Secondary- DH		Aluminum:	AL
					Prime or Secondary- Slider		Vinyl:	V
					Prime or Secondary- Fixed		Wood:	W
					Prime or Secondary - Casement/ Projected		Fiberglass:	F
					Prime or Secondary - Specialty		Other:	O
					Prime or Secondary- Patio Door			
					PERFORMANCE RATING			
					AAMA /WDMA/CSA 101/1.S.2/A440-08			
					Categories:			
					R			
					LC			
					C			
					CW			
					HC			
					AW			
DOOR PRODUCTS								
Door Product Type:	Material	Performance Rating	STC Range	Historic Applications	Door Categories		MATERIAL Categories:	
Storm Swinging	AL		29-31		PRODUCT TYPE:			
Prime Swinging	WOOD				Prime or Secondary- Swinging Door		Aluminum:	AL
Prime Swinging	AL		38-42		Prime or Secondary -Specialty Doors		Vinyl:	V
Prime Swinging	AL	Hurricane	38-42				Wood:	W
							Fiberglass:	F
							Other:	O
					Historic Applications:			
					Checking this box indicates that the product listed has been approved for use in historic applications in past or current RSIP programs.			

Manufacturers Product Matrix

Matrix 3. Harvey Building Products.

ACRP Project 02-24 Guidelines for Airport Sound Insulation Programs					Manufacturers Product Matrix		July 7, 2011	
Company Name: Harvey Building Products Location: 1400 Main Street Waltham, Massachusetts 02451 Phone: 800-598-5400, Ext. 7534 E-Mail: mark.gauvin@harveybp.com					Product Attributes:			
Product Categories:					WINDOW Categories		MATERIAL Categories:	
WINDOW PRODUCTS					PRODUCT TYPE:			
Window Product Type:	Material	Performance Rating	STC Range	Historic Applications	Prime or Secondary- DH	Aluminum:	AL	
Prime - DH	V	LC	40-44		Prime or Secondary- Slider	Vinyl:	V	
Prime - SL	V	C	40-44		Prime or Secondary- Fixed	Wood:	W	
Prime - FX	V	R	40-44		Prime or Secondary - Casement/ Projected	Fiberglass:	F	
Prime - CS	V	C	35-40		Prime or Secondary - Specialty	Other:	O	
Secondary - DH	AL	VW-E	29		Prime or Secondary- Patio Door			
Secondary - SL	AL	HW-E	29		PERFORMANCE RATING AAMA /WDMA/CSA 101/I.5.2/A440-08 Categories:			
Secondary - FX	AL	FW-E	29		R			
					LC			
					C			
					CW			
					HC			
					AW			
DOOR PRODUCTS					Door Categories		MATERIAL Categories:	
Door Product Type:	Material	Performance Rating	STC Range	Historic Applications	PRODUCT TYPE:			
					Prime or Secondary- Swinging Door		Aluminum: AL	
					Prime or Secondary -Specialty Doors		Vinyl: V	
							Wood: W	
							Fiberglass: F	
							Other: O	
					Historic Applications:			
					Checking this box indicates that the product listed has been approved for use in historic applications in past or current RSIP programs.			

Manufacturers Product Matrix

Matrix 4. JB Sash & Door Co. Inc.[illegible]

Matrix 5. Sound Control Systems a Division of Larson Manufacturing.

[illegible]

Matrix 6. Marvin Windows and Doors.

ACRP Project 02-24 Guidelines for Airport Sound Insulation Programs						Manufacturers Product Matrix		July 7, 2011	
Company Name: Marvin Windows and Doors						Product Attributes:			
Location: Warroad MN									
Phone: 920-279-2409									
E-Mail: jeffvan@marvin.com									
Product Categories:									
WINDOW PRODUCTS									
	Window Product Type:	Material	Performance Rating	STC Range	Historic Applications	WINDOW Categories		MATERIAL Categories:	
	Double Hung	W/AL	LC40	STC28-38	Yes	PRODUCT TYPE:		Aluminum: AL	
	Glider	W/AL	LC50	STC27-37	yes	Prime or Secondary- DH		Vinyl: V	
	Fixed	W/AL	LC40	STC28-38	Yes	Prime or Secondary- Slider		Wood: W	
						Prime or Secondary- Fixed		Fiberglass: F	
						Prime or Secondary - Casement/ Projected		Other: O	
						Prime or Secondary - Specialty			
						Prime or Secondary- Patio Door			
						PERFORMANCE RATING			
						AAMA /WDMA/CSA 101/I.5.2/A440-08			
						Categories:			
						R			
						LC			
						C			
						CW			
						HC			
						AW			
DOOR PRODUCTS									
	Door Product Type:	Material	Performance Rating	STC Range	Historic Applications	Door Categories		MATERIAL Categories:	
						PRODUCT TYPE:		Aluminum: AL	
						Prime or Secondary- Swinging Door		Vinyl: V	
						Prime or Secondary -Specialty Doors		Wood: W	
								Fiberglass: F	
								Other: O	
						Historic Applications:			
						Checking this box indicates that the product listed has been approved for use in historic applications in past or current RSIP programs.		X	

Matrix 7. Pella Windows and Doors.

[illegible]

Matrix 8. PEM Millwork of Minnesota, Inc.

ACRP Project 02-24

Guidelines for Airport Sound Insulation Programs

Manufacturers Product Matrix

July 7, 2011

Company Name: PEM Millwork of Minnesota, Inc.					Product Attributes:	
Location: 5671 International Parkway						
New Hope, MN 55428						
Phone: 763-541-1133					WINDOW Categories	
E-Mail: rustv@pemmillwork.com					PRODUCT TYPE:	
Product Categories:					MATERIAL Categories:	
WINDOW PRODUCTS						
Window Product Type:	Material	Performance Rating	STC Range	Historic Applications	Prime or Secondary- DH	Aluminum: AL
					Prime or Secondary- Slider	Vinyl: V
					Prime or Secondary- Fixed	Wood: W
					Prime or Secondary - Casement/ Projected	Fiberglass: F
					Prime or Secondary - Specialty	Other: O
					Prime or Secondary- Patio Door	
					PERFORMANCE RATING	
					AAMA /WDMA/CSA 101/I.5.2/A440-08	
					Categories:	
					R	
					LC	
					C	
					CW	
					HC	
					AW	
DOOR PRODUCTS						
Door Product Type:	Material	Performance Rating	STC Range	Historic Applications	Door Categories	
Stile & Rail	Wood		31		PRODUCT TYPE:	
Flush	Wood		41		Prime or Secondary- Swinging Door	
Fiberglass	Fiberglass		29		Prime or Secondary -Specialty Doors	
Steel	Steel		25			
					Historic Applications:	
					Checking this box indicates that the product listed has been approved for use in historic applications in past or current RSIP programs.	
					xx	

Manufacturers Product Matrix

Company Name: Sound Solutions Windows & Doors					Product Attributes:				
Location: 4422 W. 46th St.					WINDOW Categories:				
Chicago, IL 60632					PRODUCT TYPE:				
Phone: 609-598-2317					Prime or Secondary- DH				
E-Mail: Mmcshane@sswds.com					Prime or Secondary- Slider				
Product Categories:					Prime or Secondary- Fixed				
WINDOW PRODUCTS					Prime or Secondary - Casement/ Projected				
Window Product Type:	Material	Performance Rating	STC Range	Historic Applications	Prime or Secondary - Specialty				
Acoust DH	V Comp	LC PG30	31-45		Prime or Secondary- Patio Door				
Acoust SL	V Comp	LC PG30	31-44		PERFORMANCE RATING				
Acoust FX	V Comp	CW PG30	32-44		AAMA /WDMA/CSA 101/1.5.2/A440-08				
Acoust CSMT	V Comp	R PG30	31-41		Categories:				
Acoust PROJ	V Comp	R PG30	31-41		R				
Acoust Spec	V Comp	CW PG30	31-44		LC				
Acoust Storm DH	AL	VWE 25	30		C				
Acoust Storm SL	AL	HWE 15	28		CW				
Acoust Storm FX	AL	FEW 15	29		HC				
DOOR PRODUCTS					AW				
Door Product Type:	Material	Performance Rating	STC Range	Historic Applications	Door Categories:				
					PRODUCT TYPE:				
					Prime or Secondary- Swinging Door				
					Prime or Secondary -Specialty Doors				
					Aluminum: AL				
					Vinyl: V				
					Wood: W				
					Fiberglass: F				
					Other: O				
					Historic Applications:				
					Checking this box indicates that the product				
					listed has been approved for use in historic				
					applications in past or current RSIP programs.				

Matrix 10. Torrance Aluminum.

ACRP Project 02-24 Guidelines for Airport Sound Insulation Programs						Manufacturers Product Matrix		July 7, 2011	
Company Name:						Torrance Aluminum			
Location:						22850 Perry Street			
						Perris, CA 92570			
Phone:						800-433-5648			
E-Mail:						jjohnston@torrancealuminum.com			
Product Categories:									
WINDOW PRODUCTS									
Window Product Type:		Material	Performance Rating	STC Range	Historic Applications	WINDOW Categories			
Prime - Casement/ Projected		AL	AW/Hc	35-44		PRODUCT TYPE:			
Prime - Slider		AL	HC	39		Prime or Secondary- DH			
						Prime or Secondary- Slider			
						Prime or Secondary- Fixed			
						Prime or Secondary - Casement/ Projected			
						Prime or Secondary - Specialty			
						Prime or Secondary- Patio Door			
DOOR PRODUCTS						PERFORMANCE RATING			
Door Product Type:		Material	Performance Rating	STC Range	Historic Applications	AAMA /WDMA/CSA 101/I.5.2/A440-08			
Prime - Sliding Door		AL	HC	38-39		Categories:			
Prime - Sliding Door		AL	C	36-39		R			
Prime - Swinging Door		AL	HC	37-43		LC			
Secondary - Sliding Door		AL	R			C			
						CW			
						HC			
						AW			
DOOR CATEGORIES						DOOR Categories			
PRODUCT TYPE:						PRODUCT TYPE:			
Prime or Secondary- Swinging Door						Prime or Secondary- Swinging Door			
Prime or Secondary-Specialty Doors						Prime or Secondary-Specialty Doors			
Historic Applications:						Historic Applications:			
Checking this box indicates that the product listed has been approved for use in historic applications in past or current RSIP programs.						Checking this box indicates that the product listed has been approved for use in historic applications in past or current RSIP programs.			

Manufacturers Product Matrix

Matrix 11. VPI Quality Windows.

[illegible]



APPENDIX D

Buy American Guidance Letter



U.S. Department
of Transportation
**Federal Aviation
Administration**

Memorandum

Subject: **ACTION:** Program Guidance Letter 10-02

Date: February 24, 2010

From: Manager, Airports Financial Assistance Division,
APP-500

Reply to
Attn. of: Nancy S. Williams
202-267-8822

To: PGL Distribution List

We are issuing this Program Guidance Letter on Buy American requirements.

A handwritten signature in black ink, appearing to read "F. San Martin".

Frank J. San Martin

PGL 10-02

February 24, 2010

Guidance for Buy American on Airport Improvement Program (AIP) or American Recovery and Reinvestment Act (ARRA) projects.

In accepting AIP or ARRA funding, grant recipients are certifying that they will not acquire (or permit any contractor or subcontractor) to use any steel or manufactured products produced outside the United States on any portion of the project for which funds are provided, unless otherwise approved by the FAA. Therefore, for the AIP or ARRA funded portion of a project, grant recipients must either:

1. Certify, in writing, all products are wholly produced in the US of US materials, or
2. Request a waiver to use non-US produced products, or
3. Certify that all equipment that is being used on the project is on the Nationwide Buy American conformance list.

The AIP funded portion of a project includes the grant recipient's local share.

Types of Waivers

There are four types of waivers to Buy American:

1. Public interest waiver;
2. Insufficient quantity AND quality for ARRA (AIP projects allow waivers for insufficient quantity OR quality);
3. 60% or more of the components and subcomponents in the facility or equipment are of US origin and final assembly is in the US; or
4. Applying Buy American increases the cost of the overall project by more than 25%.

Many pieces of equipment are constructed with some non-US produced components or subcomponents. Therefore, it is expected that the majority of grants will have waivers issued unless the project is constructed of materials that already have a nationwide waiver.

Nationwide Waiver

Much of the equipment that is frequently used on AIP or ARRA projects has been reviewed by FAA Headquarters and a nationwide waiver has been issued. The Nationwide Buy American conformance list is posted on the www.faa.gov website at the following address:

http://www.faa.gov/airports/aip/procurement/federal_contract_provisions/
by clicking the tab, "Equipment Meeting Buy American Requirements"

If the equipment is on the nationwide waiver list, no additional waiver is required.

Who can Issue Waivers

Only FAA headquarters may issue waivers for reasons 1 and 2. FAA field offices (Regional Offices and/or Airports District Offices) may issue waivers for reasons 3 and 4.

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For block grant state projects, the FAA must issue the waivers. Block grant states are not allowed to issue a waiver.

Defining the Project, Facility and Equipment, and Final Assembly Location in the 60% US final assembly waiver

The waiver can be considered if "at least 60% of the cost of the components and subcomponents in the **facility or equipment** are produced in the United States and the final assembly of the facility or equipment has occurred in the United States." The correct application of the terms is discussed below.

Project

The "Project" is generally the project that is being bid. The "Project" does not extend over multiple grants or phases, even though the overall project may be phased or may be built in multiple bid packages.

Facility or Equipment

- For a building, the portion of the building that is being funded under the AIP or ARRA grant is the "facility" listed in the waiver.
- For other projects, the bid items as described in the latest edition of FAA Advisory Circular 5370-10 will generally be the "equipment" referred to in the waiver except for airfield electrical equipment.
- For airfield electrical equipment, the "L-" items listed in the Addendum to FAA Advisory Circular 5345-53C, latest edition will generally be the "equipment" referred to in the waiver.
- For a vehicle or single piece of equipment like a snow plow or ARFF vehicle, the single vehicle itself is the "equipment."

Final Assembly Location and Labor Exclusion

Final assembly is the substantial transformation of the various components and subcomponents into the equipment. For a building, the final assembly is actual construction of the building.

- For any project other than a building project, the final assembly location is the location where the equipment is assembled, **not the project site itself.**
- For a building, the final assembly location is the airport building site.

In any calculation of Buy American percentage, the labor for the final assembly is excluded. This is because the Buy American statute is based on the cost of materials and equipment, not labor. For a building, this means that only the costs of the materials as they are delivered to the airport site are considered when calculating US and non-US component and subcomponent costs. For equipment, the costs of the final assembly at the manufacturing site are excluded.

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Common Materials that are waived or excluded from Buy American - Cement, Concrete, Asphalt and Steel

Cement and concrete is excluded from the Buy American preference requirements (although the steel used for reinforcement, ties, stirrups, etc. must meet Buy American.)

Asphalt and other petroleum products are waived as an excepted item under AMS Guidance T3.6.4.1.e: Foreign Acquisition – Definitions identifying Asphalt as a petroleum product.

Steel is specifically identified in the statute. Therefore, all rebar and discrete, identifiable steel components must be manufactured in the United States.

FAA Waiver

After the FAA has determined that the final assembly location is in the US and the percent of US components and subcomponents is above 60%, a waiver may be issued. The waiver is for the single project – not a nationwide waiver.

What Information is required to Issue a Waiver (AIP and ARRA) and for the Federal Register Notice (ARRA)

For waiver type 3, a waiver can be considered if “at least 60% of the cost of the components and subcomponents in the facility or equipment are produced in the United States and the final assembly of the facility or equipment has occurred in the United States.”

Grant recipients must request waivers from FAA in writing, with sufficient supporting information. Grant recipients are responsible for ensuring their waiver request is complete and accurate using project specific information provided directly by the contractor or the contractor's supplier.

The FAA will conduct its review and approval based on the information provided by the grant recipient.

The information that must be provided for either equipment or for a building:

- Project Number
- Project Name
- Airport Name
- Total Project Cost
- Total Equipment or Bid Item Cost for which the waiver is being requested
- Total Equipment or Bid Item Cost excluding labor for final assembly.

For equipment, the following additional information is required:

- The equipment or bid item for which the waiver is being requested
- The manufacturer and country of origin of the equipment or bid item.
- The location of the final assembly of the equipment or bid item (not the airport site)

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- The cost of the US components and subcomponents for the equipment or bid item for which the waiver is being requested
- The cost of the non-US components and subcomponents for the equipment or bid item for which the waiver is being requested
- The resulting percent of US and non-US components

For a building, the following additional information is required:

- The building (called the facility in the Buy American statute) for which the waiver is being requested
- The manufacturer and country of origin of the US and non-US materials that will be used in the building.
- For a building, the location of the final assembly is the airport site
- The cost of the US components and subcomponents for the equipment or bid item for which the waiver is being requested
- The cost of the non-US components and subcomponents for the equipment or bid item for which the waiver is being requested
- The resulting percent of US and non-US components

Grant recipients are urged to submit waiver requests as early as possible.

Waivers that are issued on ARRA projects must be included in a Federal Register notice, which will generally be published on a quarterly basis.

Sample Letter of Approval of Waiver:

When FAA is satisfied that a waiver may be issued based on the 60%/US final assembly criteria, a letter must be written to the airport sponsor approving the waiver. The text of the letter follows.

A copy of the letter must be forwarded to APP-500 along with a copy of the supporting documentation that was submitted by the airport for the waiver. The information used in the letter will be the basis of the Federal Register notice. The Federal Register notice may include copies of the waiver letters or will be a tabular listing of the waivers. Therefore, regions must forward both a *.pdf copy of the signed letter and an editable copy of the letter.

XXXX Airport
AIP-Project No. X-XX-XXXX-XX
Project Name
Waiver of Buy American Requirements

I have reviewed the request for Waiver of Buy American Requirement submitted XXX for the use of XXXXX equipment on the subject project. The information submitted by the airport for:

Item for which waiver is being issued: i.e L-831 Transformers
Manufacturer:
Final Assembly Location:

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Percent US Components and Subcomponents:

The information submitted satisfies the requirement for waiver of the requirements of the Buy American per 49 USC Section 50101 based on over 60% of the cost of components and subcomponents to be used in the project being produced in the United States.

The waiver is hereby approved for use on this AIP grant project.

Common Misconceptions

- Belief that if a manufacturer is "FAA-certified" that Buy America has been satisfied. This is not true. The FAA certification certifies that technical standards have been met. However, FAA-certified equipment manufactured outside the U.S. does not meet Buy America provisions of the AIP unless a waiver has been issued.
- Misconception that the North America Free Trade Act (NAFTA) exempts equipment manufactured in Mexico or Canada from "Buy America" requirements. This is not true for AIP or ARRA projects.

Text of Buy American statute from 49 United States Code §50101

§ 50101. Buying goods produced in the United States

(a) Preference.— The Secretary of Transportation may obligate an amount that may be appropriated to carry out section 106 (k), 44502 (a)(2), or 44509, subchapter I of chapter 471 (except section 47127), or chapter 481 (except sections 48102 (e), 48106, 48107, and 48110) of this title for a project only if steel and manufactured goods used in the project are produced in the United States.

(b) Waiver.— The Secretary may waive subsection (a) of this section if the Secretary finds that—

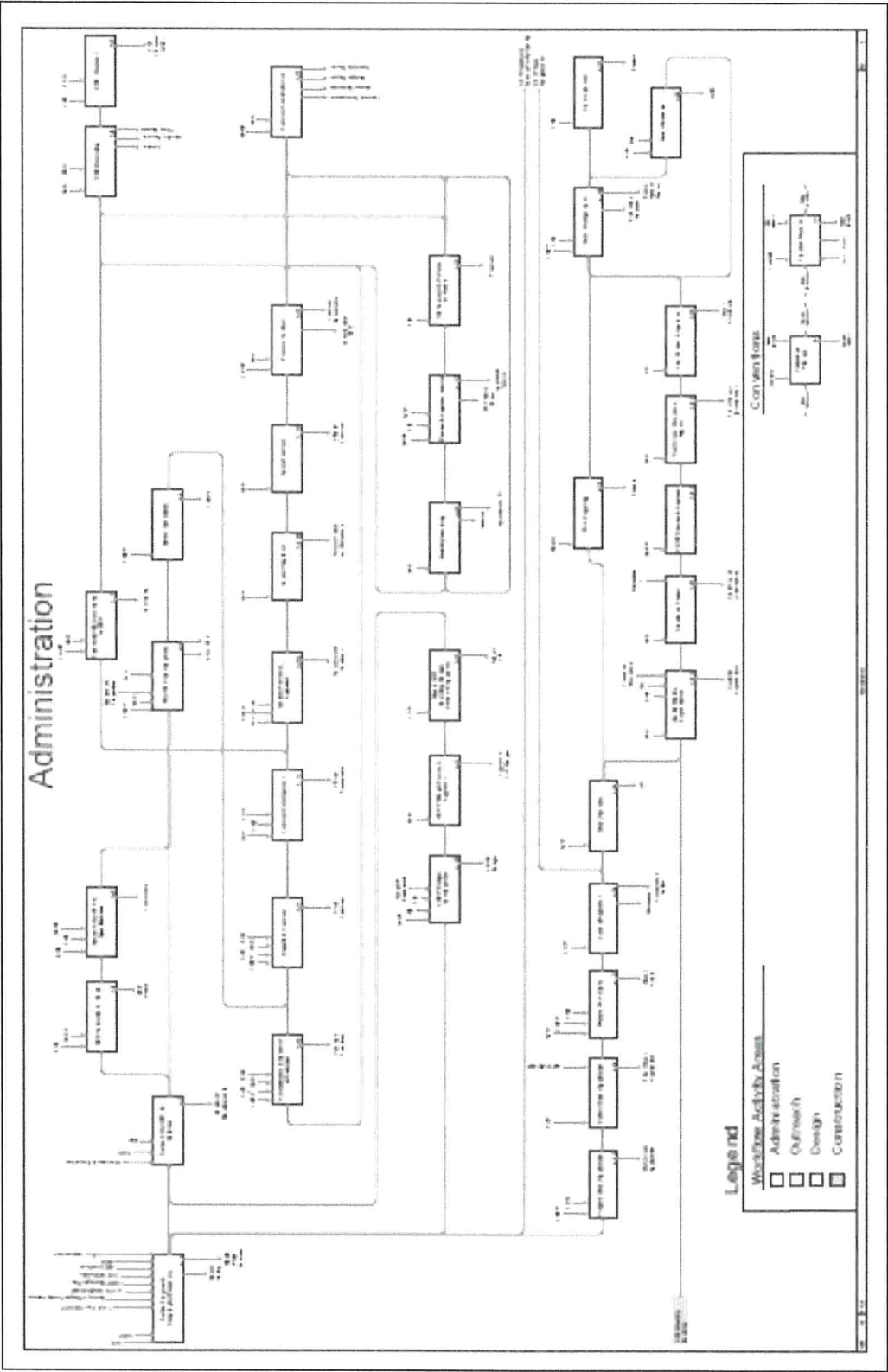
- (1) applying subsection (a) would be inconsistent with the public interest;
 - (2) the steel and goods produced in the United States are not produced in a sufficient and reasonably available amount or are not of a satisfactory quality;
 - (3) when procuring a facility or equipment under section 44502 (a)(2) or 44509, subchapter I of chapter 471 (except section 47127), or chapter 481 (except sections 48102 (e), 48106, 48107, and 48110) of this title—
 - (A) the cost of components and subcomponents produced in the United States is more than 60 percent of the cost of all components of the facility or equipment; and
 - (B) final assembly of the facility or equipment has occurred in the United States; or
 - (4) including domestic material will increase the cost of the overall project by more than 25 percent.
- (c) Labor Costs.— In this section, labor costs involved in final assembly are not included in calculating the cost of components.



APPENDIX E

Project Closeout and Reporting

Exhibit 1. Administration Workflow Chart.



Courtesy of Psomas

Exhibit 2. Selection of Consultants.

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION
AIRPORT IMPROVEMENT PROGRAM
SPONSOR CERTIFICATION
SELECTION OF CONSULTANTS

(Sponsor) _____
(Airport) AIP

(Project Number)

Title 49, United States Code, section 47105(d), authorizes the Secretary to require certification from the sponsor that it will comply with the statutory and administrative requirements in carrying out a project under the Airport Improvement Program (AIP). General standards for selection of consultant services within Federal grant programs are described in Title 49, Code of Federal Regulations (CFR), Part 18.36. Sponsors may use other qualifications-based procedures provided they are equivalent to specific standards in 49 CFR 18 and FAA Advisory Circular 150/5100-14, Architectural, Engineering, and Planning Consultant Services for Airport Grant Projects.

Except for the certified items below marked not applicable (N/A), the list includes major requirements for this aspect of project implementation, although it is not comprehensive, nor does it relieve the sponsor from fully complying with all applicable statutory and administrative standard.

	Yes	No	N/A
1. Solicitations were (will be) made to ensure fair and open competition from a wide area of interest.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2. Consultants were (will be) selected using competitive procedures based on qualifications, experience, and disadvantaged enterprise requirements with the fees determined through negotiations.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3. A record of negotiations has been (will be) prepared reflecting considerations involved in the establishment of fees, which are not significantly above the sponsor's independent cost estimate.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4. If engineering or other services are to be performed by sponsor force account personnel, prior approval was (will be) obtained from the FAA.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5. The consultant services contracts clearly establish (will establish) the scope of work and delineate the division of responsibilities between all parties engaged in carrying out elements of the project.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6. Costs associated with work ineligible for AIP funding are (will be) clearly identified and separated from eligible items in solicitations, contracts, and related project documents.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7. Mandatory contract provisions for grant-assisted contracts have been (will be) included in consultant services contracts.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
8. The cost-plus-percentage-of-cost methods of contracting prohibited under Federal standards were not (will not be) used.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

- | | Yes | No | N/A |
|--|--------------------------|--------------------------|--------------------------|
| 9. If the services being procured cover more than the single grant project referenced in this certification, the scope of work was (will be) specifically described in the advertisement, and future work will not be initiated beyond five years. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

I certify, for the project identified herein, responses to the forgoing items are accurate as marked and have prepared documentation attached hereto for any item marked "no" that is correct and complete.

(Name of Sponsor)

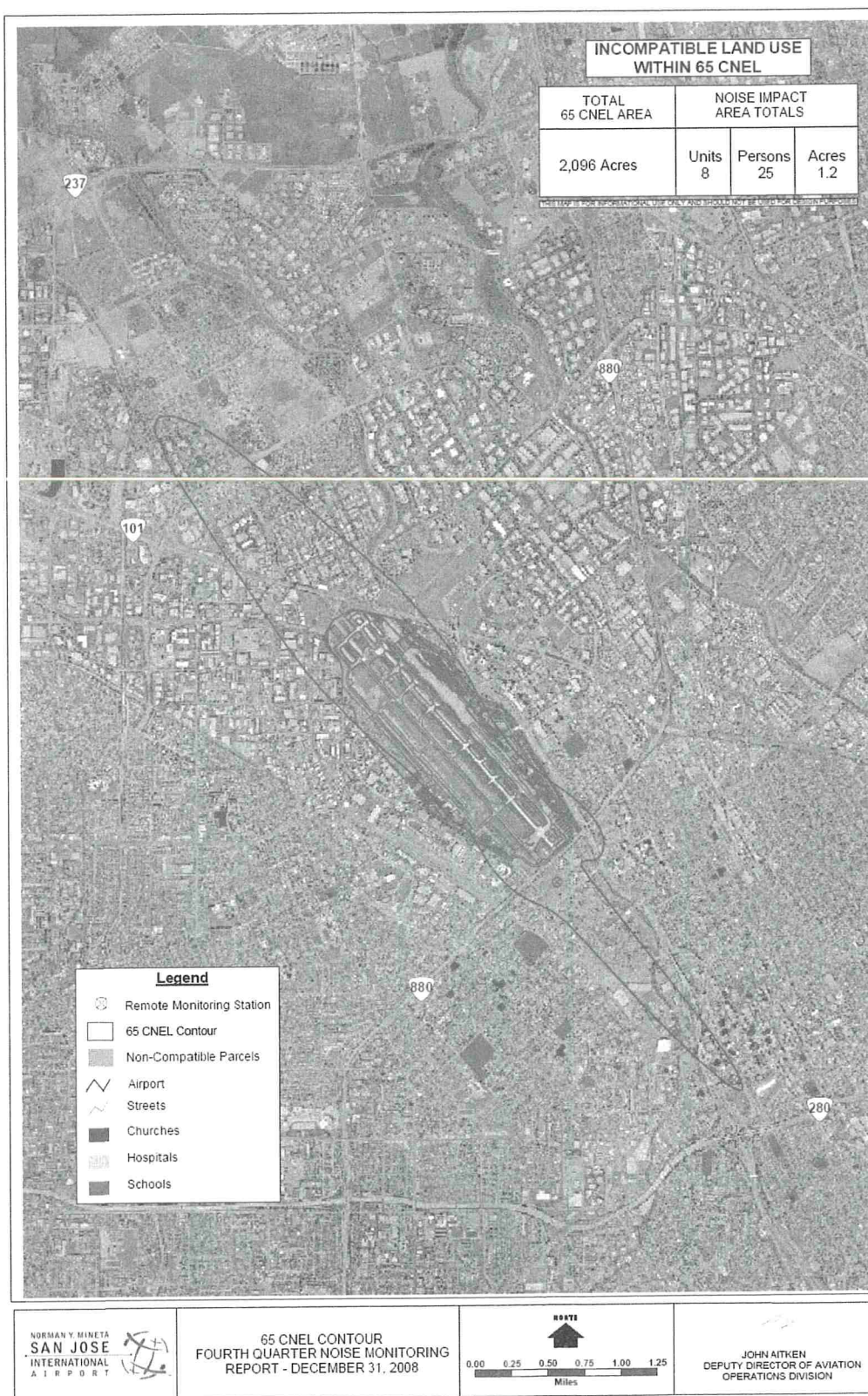
(Signature of Sponsor's Designated Official Representative)

(Typed Name of Sponsor's Designated Official Representative)

(Typed Title of Sponsor's Designated Official Representative)

(Date)

Exhibit 3. Property Map.



Courtesy of San Jose International Airport

Exhibit 4. Project Closeout Report.

PROJECT CLOSEOUT REPORT

Airport name
City, State
AIP 3-xx-xxxx-xx-xx

XX, 20XX

A. Project Summary

Airport:

Location:

Project Number:

Grant Agreement Acceptance Date:

Grant Agreement Amount:

Amendment No. 1

Date/Amount:

Primary Purpose:

Amendment No. 2

Date/Amount:

Primary Purpose:

Maximum Existing Grant Obligation:

Sponsor(s):

Basic Federal Participation Rate: XX%

Project Description (with all amendments):

Brief narrative of work accomplished

Describe how the program was planned and activities.

Examples

- Administration
- Outreach
- Design
- Construction
- Closeout

Describe the elements of the the F.A.R. Part 150 Noise Compatibility Study to improve the compatibility between aircraft operations and noise sensitive land uses in the identified noise impact area.

Examples

- Noise Mitigation Element
- Land Use Planning Element

- Include explanation for any deleted work item
- Provide description of non-participating work item

Summary of key milestone dates

- Receipt of Bids
- Notice-to-proceed
- Substantial completion
- Contract date
- Final inspection
- Final acceptance

Contract Time

- Explanation of liquidated damages (if required)
- Justification for weather delays (calendar contracts require submittal of NWS data to justify weather events in excess of the normal monthly events)

Identify work items with % participation rate other than basic rate above by indicating % rates after work item.

B. Executive Summary*Program Budget*

Describe program budget and expenses

Historic Properties

Describe any Section 106 activities and related construction to historical properties.

Land Use Compatibility

List the statistics that summarize the sound mitigation efforts for your program. Statistics can be taken for Part 150 study.

Sound Mitigation Services

Eligible Properties

Single Family Homes Eligible	XXXX	
Population impacted by aircraft noise (single family homes)		XXXX
Single Family Homes Completed	XXXX	
Population of sound mitigated single family homes		XXXX
Remaining untreated single family homes	XXX	
Remaining population impacted by aircraft noise		XXXX

Labor Provisions

- Statement of compliance with contract labor provisions (payroll reviews, complaints, etc.). Reference AC 150/5100-6
- Summary of any complaints/findings and how they were resolved

Administrative Costs

- Brief explanation of claimed costs
- Refer to Section 310.c of FAA Order 5100.38c for eligibility provisions

Engineering Costs

- Brief explanation of claimed costs
- Delineation of eligible and ineligible costs

Force Account

- Identify FAA approval date
- Provide listing of claimed costs
- Provide supporting documentation if not already submitted with drawdown documentation
- Claims for Wages and Salaries must comply with OMB A-87 requirements and may not be arbitrary or prorated
- Sponsors may not claim indirect costs unless they have a prior approved cost allocation plan

Construction Costs

- Summary of final contract quantities
- Delineation of eligible and ineligible costs
- Clearly identify added or deleted work items
- Explanation/justification of underruns and overruns
- Summary of Change Order and supplemental agreements

Buy American Provisions

- Provide a sponsor/consultant statement addressing whether the contractor complied with Buy American provisions and how the sponsor/consultant verified compliance
- The sponsor shall maintain documentation that supports contractor compliance with Buy American provisions. Upon request of the FAA project manager, the sponsor must provide this documentation to the FAA as part of the closeout documentation. At a minimum, the sponsor/consultant shall maintain product information sheets and a shop drawing submittal log or summary table.

C. Project Cost Summary

NOTE: List all contracts (e.g., engineering, construction) separately.

AIP PROJECT NO: _____ LOCATION: _____

WORK ITEMS TOTAL

	Total Costs	Ineligible Costs	Allowable costs for Federal Participation
	(Total - Ineligible = Allowable)		
ADMINISTRATION:			
1. Advertisement	\$ _____	\$ _____	\$ _____
2. Audit	\$ _____	\$ _____	\$ _____
3. Other (define costs)	\$ _____	\$ _____	\$ _____
Administrative Total	\$ _____	\$ _____	\$ _____

ENGINEERING: (each consultant)

1. Project Formulation/Predesign	\$ _____	\$ _____	\$ _____
2. Design	\$ _____	\$ _____	\$ _____
3. Inspection	\$ _____	\$ _____	\$ _____
4. Amendments	\$ _____	\$ _____	\$ _____
5. Planning (ALP Update, etc.)	\$ _____	\$ _____	\$ _____
6. Other	\$ _____	\$ _____	\$ _____
Engineering Total	\$ _____	\$ _____	\$ _____

FORCE ACCOUNT

1. Design	\$ _____	\$ _____	\$ _____
2. Inspection	\$ _____	\$ _____	\$ _____
3. Construction	\$ _____	\$ _____	\$ _____
4. Planning	\$ _____	\$ _____	\$ _____
Force Account Total	\$ _____	\$ _____	\$ _____

CONSTRUCTION: (complete for each prime)

Name _____			
1. Bid	\$ _____	\$ _____	\$ _____
2. Change Order (summary)	\$ _____	\$ _____	\$ _____
3. Other (define costs)	\$ _____	\$ _____	\$ _____
Construction Total	\$ _____	\$ _____	\$ _____

LAND (include Land Acquisition Cost Breakdown, Append 5-E) \$ _____ \$ _____

EQUIPMENT: (each piece)

Name Manufacturer/Equipment	\$ _____	\$ _____	\$ _____
1. _____	\$ _____	\$ _____	\$ _____
2. _____	\$ _____	\$ _____	\$ _____
3. _____	\$ _____	\$ _____	\$ _____
Equipment Total	\$ _____	\$ _____	\$ _____

CREDIT (List any interest earned on Federal Funds<\$ _____>

PROGRAM INCOME (sales tax, equip trade-in, land sale etc. as applicable)<\$ _____>

GRAND TOTAL\$ _____

FEDERAL SHARE REQUESTED FOR REIMBURSEMENT (xx xx% X Grand Total)\$ _____

(note: The percent federal share must be rounded down to the nearest cent)

TOTAL GRANT AMOUNT (Including All Amendments)\$ _____

RECOVERY or <AMENDMENT>\$ _____

Signature of Authorized Certifying Official: _____ Date: _____
typed or printed name and title

D. Partial Payment History Summary

E. Change Order Summary

F. Final Inspection Report and Punch List Item Clearance

G. Mandatory Project Review Comments and Certification Summary

	N/A	YES	NO
1. All construction work was performed in full conformity with approved project plans and specifications.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2. All work included on approved project plans and included in the project description has been satisfactorily completed	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3. The Sponsor has not claimed costs for any development not within the scope of the project.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4. The Sponsor has complied with the terms and conditions of the Grant Agreement including all special conditions.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5. A final inspection of the project work was conducted.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6. Liquidated damages were not assessed.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7. Satisfactory record drawings have been received.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
8. All project certifications completed.			
a. Land	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
b. Plans and Specifications	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
c. Consultant Selection	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
d. Equipment	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
e. Construction Project Final Acceptance **	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

* Comment is required for any item checked in the "No" column.

H. DBE Participation Summary

Name of Prime Contractor	Amount of Contract	DBE Amount	Contract Goal - %	Actual Goal - %

I. Final Payment Recommendation and Project Amendment Requirement

(Check Appropriate Items)

- ☐ A. No further payment is due.
- ☐ B. If funds are available and the Grant is appropriately amended in the amount of \$ _____ a payment (or additional payment) of \$ _____ is recommended.
- ☐ C. A final payment in the amount of \$ _____ is recommended.
- ☐ D. Cost Backup (Included to document cost incurred as required).
- ☐ E. A-128 System Audit performed and approved on xx, 20xx by the cognizant agency _____.

All costs were necessary, reasonable in amount and otherwise allowable as project costs.

Attachments

Exhibit 9 Construction Project Final Acceptance

Exhibit 10 Project Plans & Specifications

Exhibit 11 Equipment-Construction Contracts

Exhibit 12 Real Property Acquisition (If applicable)

Exhibit 13 Financial Spreadsheet Backup Documentation

Exhibit 5. Final Outlay Report Form 271.

OUTLAY REPORT AND REQUEST FOR REIMBURSEMENT FOR CONSTRUCTION PROGRAMS		OMB APPROVAL NO. 0348-0002		PAGE _____ OF _____ PAGES	
(See instructions on back)		1. TYPE OF REQUEST <input type="checkbox"/> FINAL <input type="checkbox"/> PARTIAL		2. BASIS OF REQUEST <input type="checkbox"/> CASH <input type="checkbox"/> ACCRUAL	
3. FEDERAL SPONSORING AGENCY AND ORGANIZATIONAL ELEMENT TO WHICH THIS REPORT IS SUBMITTED		4. FEDERAL GRANT OR OTHER IDENTIFYING NUMBER ASSIGNED BY FEDERAL AGENCY		5. PARTIAL PAYMENT REQUEST NO.	
6. EMPLOYER IDENTIFICATION NUMBER	7. RECIPIENT'S ACCOUNT NUMBER OR IDENTIFYING NUMBER	8. PERIOD COVERED BY THIS REQUEST FROM (Month, day, year) TO (Month, day, year)			
9. RECIPIENT ORGANIZATION Name: No. and Street: City, State and ZIP Code:		10. PAYEE (Where check is to be sent if different from item 9) Name: No. and Street: City, State and ZIP Code:			
11. STATUS OF FUNDS					
CLASSIFICATION	PROGRAMS --	FUNCTIONS --	ACTIVITIES	TOTAL	
	(a)	(b)	(c)		
a. Administrative Expense	\$	\$	\$	\$	
b. Preliminary Expense					
c. Land, structures, right-of-way					
d. Architectural engineering basic fees					
e. Other architectural engineering fees					
f. Project inspection fees					
g. Land development					
h. Relocation expense					
i. Relocation payments to individuals and businesses					
j. Demolition and removal					
k. Construction and project improvement cost					
l. Equipment					
m. Miscellaneous cost					
n. Total cumulative to date (Sum of lines a through m)					
o. Deductions for program income					
p. Net cumulative to date (Line n minus Line o)					
q. Federal share to date					
r. Rehabilitation grants (100% reimbursement)					
s. Total Federal share (Sum of Lines q and r)					
t. Federal payments previously requested					
u. Amount requested for reimbursement	\$	\$	\$	\$	
v. Percent of project completed	%	%	%	%	
12. CERTIFICATION I certify that to the best of my knowledge and belief the billed costs of disbursements are in accordance with the terms of the project and that the reimbursement represents the Federal share due which has not been previously requested and that an inspection has been performed and all work is in accordance with the terms of the grant.		SIGNATURE OF AUTHORIZED CERTIFYING OFFICIAL		DATE REPORT SUBMITTED	
		a. RECIPIENT		TYPED OR PRINTED NAME OR TITLE	
		b. REPRESENTATIVE CERTIFYING TO LINE 11V		SIGNATURE OF AUTHORIZED CERTIFYING OFFICIAL	
TYPED OR PRINTED NAME OR TITLE					

AUTHORIZED FOR LOCAL REPRODUCTION
PREVIOUS EDITION USABLE
271-103

STANDARD FORM 271 (Rev. 7-97)
Prescribed by OMB Circular A-102 and A-110

INSTRUCTIONS

Public reporting burden for this collection of information is estimated to average 60 minutes per response, including time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding the burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to the Office of Management and Budget, Paperwork Reduction Project (0348-0004), Washington, DC 20503.

PLEASE DO NOT RETURN YOUR COMPLETED FORM TO THE OFFICE OF MANAGEMENT AND BUDGET. SEND IT TO THE ADDRESS PROVIDED BY THE SPONSORING AGENCY.

Please type or print legibly. Items 3, 4, 5, 8, 9, 10, 11s and 11v are self explanatory, specific instructions for other items are as follows:

Item	Entry	Item	Entry
1	Mark the appropriate box. If the request is final, the amounts billed should represent the final cost of the project.	11j	Enter gross salaries and wages of employees of the recipient and payments to third party contractors directly engaged in performing demolition or removal of structures from developed land. All proceeds from the sale of salvage or the removal of structures should be credited to this account, thereby reflecting net amounts if required by the Federal agency.
2	Show whether amounts are computed on an accrued expenditure or cash disbursement basis.	11k	Enter those amounts associated with the actual construction of, addition to, or restoration of a facility. Also include in this category, the amounts for project improvements such as sewers, streets, landscaping, and lighting.
6	Enter the Employer Identification number (EIN) assigned by the U.S. Internal Revenue Service or FICE (institution) code if requested by the Federal agency.	11l	Enter amounts for all equipment, both fixed and movable, exclusive of equipment used for construction. For example, permanently attached laboratory tables, built-in audio visual systems, movable desks, chairs, and laboratory equipment.
7	This space is reserved for an account number or other identifying number that may be assigned by the recipient.	11m	Enter the amounts of all items not specifically mentioned above.
11	The purpose of vertical columns (a) through (c) is to provide space for separate cost breakdowns when a large project has been planned and budgeted by program, function or activity. If additional columns are needed, use as many additional forms as needed and indicate page number in space provided in upper right; however, the summary totals of all programs, functions, or activities should be shown in the "total" column on the first page. All amounts are reported on a cumulative basis.	11n	Enter the total cumulative amount to date which should be the sum of lines a through m.
11a	Enter amounts expended for such items as travel, legal fees, rental of vehicles and any other administrative expenses. Include the amount of interest expense when authorized by program legislation. Also show the amount of interest expense on a separate sheet.	11o	Enter the total amount of program income applied to the grant or contract agreement except income included on line j. Identify on a separate sheet of paper the sources and types of the income.
11b	Enter amounts pertaining to the work of locating and designing, making surveys and maps, sinking test holes, and all other work required prior to actual construction.	11p	Enter the net cumulative amount to date which should be the amount shown on line n minus the amount on line o.
11c	Enter all amounts directly associated with the acquisition of land, existing structures and related right-of-way.	11q	Enter the Federal share of the amount shown on line p.
11d	Enter basic fees for services of architectural engineers.	11r	Enter the amount of rehabilitation grant payments made to individuals when program legislation provides 100 percent payment by the Federal agency.
11e	Enter other architectural engineering services. Do not include any amounts shown on line d.	11t	Enter the total amount of Federal payments previously requested, if this form is used for requesting reimbursement.
11f	Enter inspection and audit fees of construction and related programs.	11u	Enter the amount now being requested for reimbursement. This amount should be the difference between the amounts shown on lines s and t. If different, explain on a separate sheet.
11g	Enter all amounts associated with the development of land where the primary purpose of the grant is land improvement. The amount pertaining to land development normally associated with major construction should be excluded from this category and entered on line k.	12a	To be completed by the official recipient official who is responsible for the operation of the program. The date should be the actual date the form is submitted to the Federal agency.
11h	Enter the dollar amounts used to provide relocation advisory assistance and net costs of replacement housing (last resort). Do not include amounts needed for relocation administrative expenses; these amounts should be included in the amounts shown on line a.	12b	To be completed by the official representative who is certifying to the percent of project completion as provided for in the terms of the grant agreement.
11i	Enter the amount of relocation payments made by the recipient to displaced persons, farms, business concerns, and nonprofit organizations.		

Exhibit 6. Construction Project Final Acceptance.

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION
AIRPORT IMPROVEMENT PROGRAM
SPONSOR CERTIFICATION
CONSTRUCTION PROJECT FINAL ACCEPTANCE

(Sponsor)
Description of Work:

(Airport)

(Project Number)

Title 49, United States Code, section 47105(d), authorizes the Secretary to require certification from the sponsor that it will comply with the statutory and administrative requirements in carrying out a project under the Airport Improvement Program. General standards for final acceptance and close out of federally funded construction projects are in Title 49, Code of Federal Regulations, Part 18.50. The sponsor shall determine that project costs are accurate and proper in accordance with specific requirements of the grant agreement and contract documents.

Except for the certified items below marked not applicable (N/A), the list includes major requirements for this aspect of project implementation, although it is not comprehensive, nor does it relieve the sponsor from fully complying with all applicable statutory and administrative standards.

	Yes	No	N/A
1. The personnel engaged in project administration, engineering supervision, construction inspection and testing were or will be determined to be qualified as well as competent to perform the work.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2. Daily construction records were or will be kept by the resident engineer/construction inspector as follows:			
a. Work in progress,			
b. Quality and quantity of materials delivered,			
c. Test locations and results,			
d. Instructions provided the contractor,	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
e. Weather conditions,			
f. Equipment use,			
g. Labor requirements,			
h. Safety problems, and			
i. Changes required.			
3. Weekly payroll records and statements of compliance were or will be submitted by the prime contractor and reviewed by the sponsor for Federal labor and civil rights requirements (Advisory Circulars 150/5100-6 and 150/5100-15).	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4. Complaints regarding the mandated Federal provisions set forth in the contract documents have been or will be submitted to the FAA.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5. All tests specified in the plans and specifications were or will be performed and the test results documented as well as made available to the FAA.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6. For any test results outside of allowable tolerances, appropriate corrective actions were or will be taken.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

	Yes	No	N/A
7. Payments to the contractor were or will be made in compliance with contract provisions as follows:			
a. Payments are verified by the sponsor's internal audit of contract records kept by the resident engineer, and	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
b. If appropriate, pay reduction factors required by the specifications are applied in computing final payments and a summary of pay reductions made available to the FAA.			
8. The project was or will be accomplished without significant deviations, changes, or modifications from the approved plans and specifications, except where approval is obtained from the FAA.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
9. A final project inspection was or will be conducted with representatives of the sponsor and the contractor and project files contain documentation of the final inspection.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
10. Work in the grant agreement was or will be physically completed and corrective actions required as a result of the final inspection are completed to the satisfaction of the sponsor.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
11. If applicable, the as-built plans, an equipment inventory, and a revised airport layout plan have been or will be submitted to the FAA.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
12. Applicable close out financial reports have been or will be submitted to the FAA.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

I certify, for the project identified herein, responses to the forgoing items are accurate as marked and have prepared documentation attached hereto for any item marked "no" that is correct and complete.

(Name of Sponsor)

(Signature of Sponsor's Designated Official Representative)

(Typed Name of Sponsor's Designated Official Representative)

(Typed Title of Sponsor's Designated Official Representative)

(Date)

Exhibit 7. Project Plans and Specifications.

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION
AIRPORT IMPROVEMENT PROGRAM
SPONSOR CERTIFICATION
PROJECT PLANS AND SPECIFICATIONS

(Sponsor)

(Airport)

(Project Number)

Title 49, United States Code, section 47105(d), authorizes the Secretary to require certification from the sponsor that it will comply with the statutory and administrative requirements in carrying out a project under the Airport Improvement Program (AIP). AIP standards are generally described in FAA Advisory Circular (AC) 150/5100-6, Labor Requirements for the Airport Improvement Program, AC 150/5100-15, Civil Rights Requirements for the Airport Improvement Program, and AC 150/5100-16, Airport Improvement Program Grant Assurance One--General Federal Requirements. A list of current advisory circulars with specific standards for design or construction of airports as well as procurement/installation of equipment and facilities is referenced in standard airport sponsor Grant Assurance 34 contained in the grant agreement.

Except for the certified items below marked not applicable (N/A), the list includes major requirements for this aspect of project implementation, although it is not comprehensive, nor does it relieve the sponsor from fully complying with all applicable statutory and administrative standards.

	Yes	No	N/A
1. The plans and specifications were (will be) prepared in accordance with applicable Federal standards and requirements, so no deviation or modification to standards set forth in the advisory circulars, or State standard, is necessary other than those previously approved by the FAA.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2. Specifications for the procurement of equipment are not (will not be) proprietary or written so as to restrict competition. At least two manufacturers can meet the specification.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3. The development included (to be included) in the plans is depicted on the airport layout plan approved by the FAA.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4. Development that is ineligible for AIP funding has been (will be) omitted from the plans and specifications.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5. The process control and acceptance tests required for the project by standards contained in Advisory Circular 150/5370-10 are (will be) included in the project specifications.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6. If a value engineering clause is incorporated into the contract, concurrence was (will be) obtained from the FAA.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7. The plans and specifications incorporate (will incorporate) applicable requirements and recommendations set forth in the Federally approved environmental finding.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

- | | Yes | No | N/A |
|--|--------------------------|--------------------------|--------------------------|
| 8. For construction activities within or near aircraft operational areas, the requirements contained in Advisory Circular 150/5370-2 have been (will be) discussed with the FAA as well as incorporated into the specifications, and a safety/phasing plan has FAA's concurrence, if required. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 9. The project was (will be) physically completed without Federal participation in costs due to errors and omissions in the plans and specifications that were foreseeable at the time of project design. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

I certify, for the project identified herein, responses to the forgoing items are accurate as marked and have prepared documentation attached hereto for any item marked "no" that is correct and complete.

(Name of Sponsor)

(Signature of Sponsor's Designated Official Representative)

(Typed Name of Sponsor's Designated Official Representative)

(Typed Title of Sponsor's Designated Official Representative)

(Date)

Exhibit 8. Equipment Construction Contracts.

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION
AIRPORT IMPROVEMENT PROGRAM
SPONSOR CERTIFICATION
EQUIPMENT/CONSTRUCTION CONTRACTS

(Sponsor)	(Airport)	(Project Number)
Description of Work		

Title 49, United States Code (USC), section 47105(d), authorizes the Secretary to require certification from the sponsor that it will comply with the statutory and administrative requirements in carrying out a project under the Airport Improvement Program (AIP). General standards for equipment and construction contracts within Federal grant programs are described in Title 49, Code of Federal Regulations (CFR), Part 18.36. AIP standards are generally described in FAA Advisory Circular (AC) 150/5100-6, Labor Requirements for the Airport Improvement Program, AC 150/5100-15, Civil Rights Requirements for the Airport Improvement Program, and AC 150/5100-16, Airport Improvement Program Grant Assurance One--General Federal Requirements. Sponsors may use State and local procedures provided procurements conform to these Federal standards.

Except for the certified items below marked not applicable (N/A), the list includes major requirements for this aspect of project implementation, although it is not comprehensive, nor does it relieve the sponsor from fully complying with all applicable statutory and administrative standards.

	Yes	No	N/A
1. A code or standard of conduct is or will be in effect governing the performance of the sponsor's officers, employees, or agents in soliciting and awarding procurement contracts.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2. Qualified personnel are or will be engaged to perform contract administration, engineering supervision, construction inspection, and testing.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3. The procurement was or will be publicly advertised using the competitive sealed bid method of procurement.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4. The bid solicitation clearly and accurately describes or will describe:			
a. The current Federal wage rate determination for all construction projects, and	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
b. All other requirements of the equipment and/or services to be provided.			
5. Concurrence was or will be obtained from FAA prior to contract award under any of the following circumstances:			
a. Only one qualified person/firm submits a responsive bid,			
b. The contract is to be awarded to other than the lowest responsible bidder,	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
c. Life cycle costing is a factor in selecting the lowest responsive bidder, or			
d. Proposed contract prices are more than 10 percent over the sponsor's cost estimate.			

	Yes	No	N/A
6. All contracts exceeding \$100,000 require or will require the following provisions:			
a. A bid guarantee of 5 percent, a performance bond of 100 percent, and a payment bond of 100 percent;			
b. Conditions specifying administrative, contractual, and legal remedies, including contract termination, for those instances in which contractors violate or breach contract terms; and	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
c. Compliance with applicable standards and requirements issued under Section 306 of the Clean Air Act (42 USC 1857(h)), Section 508 of the Clean Water Act (33 USC 1368), and Executive Order 11738.			
7. All construction contracts contain or will contain provisions for:			
a. Compliance with the Copeland "Anti-Kick Back" Act, and			
b. Preference given in the employment of labor (except in executive, administrative, and supervisory positions) to honorably discharged Vietnam era veterans and disabled veterans.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
8. All construction contracts exceeding \$2,000 contain or will contain the following provisions:			
a. Compliance with the Davis-Bacon Act based on the current Federal wage rate determination; and	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
b. Compliance with the Contract Work Hours and Safety Standards Act (40 USC 327-330), Sections 103 and 107.			
9. All construction contracts exceeding \$10,000 contain or will contain appropriate clauses from 41 CFR Part 60 for compliance with Executive Orders 11246 and 11375 on Equal Employment Opportunity.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
10. All contracts and subcontracts contain or will contain clauses required from Title VI of the Civil Rights Act and 49 CFR 23 and 49 CFR 26 for Disadvantaged Business Enterprises.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
11. Appropriate checks have been or will be made to assure that contracts or subcontracts are not awarded to those individuals or firms suspended, debarred, or voluntarily excluded from doing business with any U.S. Department of Transportation (DOT) element and appearing on the DOT Unified List.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

I certify, for the project identified herein, responses to the forgoing items are accurate as marked and have prepared documentation attached hereto for any item marked "no" that is correct and complete.

(Name of Sponsor)

(Signature of Sponsor's Designated Official Representative)

(Typed Name of Sponsor's Designated Official Representative)

(Typed Title of Sponsor's Designated Official Representative)

(Date)

Exhibit 9. Real Property Acquisition.

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION
AIRPORT IMPROVEMENT PROGRAM
SPONSOR CERTIFICATION
REAL PROPERTY ACQUISITION

(Sponsor)	(Airport)	(Project Number)
<u>Description of Work</u>		

Title 49, United States Code, section 47105(d), authorizes the Secretary to require certification from the sponsor that it will comply with the statutory and administrative requirements in carrying out a project under the Airport Improvement Program (AIP). General requirements on real property acquisition and relocation assistance are in Title 49, Code of Federal Regulations (CFR), Part 24. The AIP project grant agreement contains specific requirements and assurances on the Uniform Relocation Assistance and Real Property Acquisition Act of 1970 (Uniform Act), as amended.

Except for the certified items below marked not applicable (N/A), the list includes major requirements for this aspect of project implementation, although it is not comprehensive, nor does it relieve the sponsor from fully complying with all applicable statutory and administrative standards.

	Yes	No	N/A
1. The sponsor's attorney or other official has or will have good and sufficient title as well as title evidence on property in the project.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2. If defects and/or encumbrances exist in the title that adversely impact the sponsor's intended use of property in the project, they have been or will be extinguished, modified, or subordinated.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3. If property for airport development is or will be leased, the following conditions have been met:			
a. The term is for 20 years or the useful life of the project,	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
b. The lessor is a public agency, and			
c. The lease contains no provisions that prevent full compliance with the grant agreement.			
4. Property in the project is or will be in conformance with the current Exhibit A property map, which is based on deeds, title opinions, land surveys, the approved airport layout plan, and project documentation.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5. For any acquisition of property interest in noise sensitive approach zones and related areas, property interest was or will be obtained to ensure land is used for purposes compatible with noise levels associated with operation of the airport.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6. For any acquisition of property interest in runway protection zones and areas related to 14 CFR 77 surfaces, property interest was or will be obtained for the following:	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
a. The right of flight,			
b. The right of ingress and egress to remove obstructions, and			
c. The right to restrict the establishment of future obstructions.			

	Yes	No	N/A
7. Appraisals prepared by qualified real estate appraisers hired by the sponsor include or will include the following:			
a. Valuation data to estimate the current market value for the property interest acquired on each parcel, and	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
b. Verification that an opportunity has been provided the property owner or representative to accompany appraisers during inspections.			
8. Each appraisal has been or will be reviewed by a qualified review appraiser to recommend an amount for the offer of just compensation, and the written appraisals as well as review appraisal are available to FAA for review.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
9. A written offer to acquire each parcel was or will be presented to the property owner for not less than the approved amount of just compensation.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
10. Effort was or will be made to acquire each property through the following negotiation procedures:			
a. No coercive action to induce agreement, and	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
b. Supporting documents for settlements included in the project files.			
11. If a negotiated settlement is not reached, the following procedures were or will be used:			
a. Condemnation initiated and a court deposit not less than the just compensation made prior to possession of the property, and	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
b. Supporting documents for awards included in the project files.			
12. If displacement of persons, businesses, farm operations, or non-profit organizations is involved, a relocation assistance program was or will be established, with displaced parties receiving general information on the program in writing, including relocation eligibility, and a 90-day notice to vacate.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
13. Relocation assistance services, comparable replacement housing, and payment of necessary relocation expenses were or will be provided within a reasonable time period for each displaced occupant in accordance with the Uniform Act.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

I certify, for the project identified herein, responses to the forgoing items are accurate as marked and have prepared documentation attached hereto for any item marked "no" that is correct and complete.

(Name of Sponsor)

(Signature of Sponsor's Designated Official Representative)

(Typed Name of Sponsor's Designated Official Representative)

(Typed Title of Sponsor's Designated Official Representative)

(Date)

Exhibit 10. Financial Spreadsheet.

[illegible]

NOTE: *Gross Eligible Costs are projected per completed home, see below
 (a) Admin. costs are calculated based on the eligible construction cost of each complete home.
 (b) Engin. Costs equal the base program design contract cost, divided by the number of completed homes.
 (c) Equip. costs equal the base program Erection contract cost, divided by the number of completed homes.
 (d) Const. costs are the total actual construction cost; negligible work is not included in the Admin or A/P fund calculations.
 **A/P Funds represent the costs for completed homes that are eligible for A/P Grant reimbursement.
 ***Local Funds represent the remaining percentage of costs that would remain after A/P Grant reimbursement.

\$0.00 Total eligible for drawdown 9-4-00

Courtesy of San Jose International Airport.



Glossary

Advisory Circular (AC) — A document published by the FAA giving guidance on aviation issues.

Air Traffic — Aircraft operating in the air or on an airport surface, exclusive of loading ramps and parking areas.

Air Traffic Control — Control of the airspace by an appropriate authority to promote the safe, orderly, and expeditious movement of terminal air traffic.

Aircraft Operation — An aircraft arrival or departure from an airport with FAA airport traffic control service. There are two types of operations: local and itinerant.

Airport — Any public-use airport, including heliports, as defined by the Aviation Safety and Noise Abatement Act of 1979 (ASNA), including: (a) any airport that is used or to be used for public purposes, under the control of a public agency, the landing area of which is publicly owned; (b) any privately owned reliever airport; and (c) any privately owned airport that is determined by the Secretary of Transportation to enplane annually 2,500 or more passengers and receive scheduled passenger service of aircraft, and which is used or to be used for public purposes.

Airport and Airway Improvement Act of 1982 — Authorizes the Secretary of Transportation to make project grants for airport planning and development to maintain a safe and efficient nationwide system of public-use airports.

Airport District Office (ADO) — The FAA area office responsible for direct dealings with airports. The FAA divides its administration into nine regions, each of which is divided into several district offices.

Airport Hazard — Any structure or object of natural growth located on or near the airport, or any use of land near the airport that obstructs the airspace required for the flight of aircraft in landing or taking off, or that is otherwise hazardous to such landing and taking off.

Airport Improvement Program (AIP) — The AIP is authorized by the Airport and Airway Improvement Act of 1982 (P.L. 97-248, as amended). The act's broad objective is to assist in the development of a nationwide system of public-use airports adequate to meet the current and projected growth of civil aviation. The act provides funding for airport planning and development projects at airports included in the National Plan of Integrated Airport Systems. The act also authorizes funds for noise compatibility planning and for carrying out noise compatibility programs as set forth in the Aviation Safety and Noise Abatement Act of 1979 (P.L. 96-143).

Airport Manager — The person authorized by the airport sponsor to exercise administrative control of the airport.

Airport Master Plan — A planning document, including appropriate documents and drawings, that describes the development of a specific airport from a physical, economic, social,

environmental, and political jurisdictional perspective. The airport layout plan drawing is part of the master plan.

Airport Noise and Capacity Act of 1990 (ANCA) — Required the establishment of a national noise policy and a requirement to eliminate Stage 2 aircraft, weighing 75,000 pounds or greater, operating in the contiguous United States by the year 2000.

Airport Noise Compatibility Program — That program, and all revisions thereto, reflected in documents (and revised documents) developed in accordance with Appendix B of 14 CFR Part 150, including the measures proposed or taken by the airport owner to reduce existing incompatible land uses and to prevent the introduction of additional incompatible land uses within the area.

Airport Operations — The total number of movements in landings (arrivals) plus takeoffs (departures) from an airport.

Airport Owner — Any person or authority having the operational control of an airport as defined in the ASNA.

Airport Safety and Noise Abatement (ASNA) Act — Established a process for addressing airport noise and land use compatibility around the nation's airports. ASNA led to the promulgation of Federal Aviation Regulation (FAR) Part 150 (Airport Noise Compatibility Planning).

Airport Sponsor — A public agency or tax-supported organization, such as an airport authority, which is authorized to own and operate the airport, to obtain property interests, to obtain funds, and to legally, financially, and otherwise be able to meet all applicable requirements of current laws and regulations.

Airspace — The space lying above the earth or above a certain area of land or water that is necessary to conduct aviation operations.

Ambient Noise — The total amount of background noise in a given place and time in the absence of an intrusive noise event. This is usually a composite of sounds from varying sources at varying distances.

American Architectural Manufacturers Association (AAMA) — Provides industry standards for windows, doors, and other architectural products.

American National Standards Institute (ANSI) — A private, nonprofit organization that oversees the development of voluntary consensus standards.

American Society for Testing and Materials (ASTM) — An international standards organization that develops and publishes voluntary consensus technical standards for a wide range of materials, products, systems, and services.

Approach Surface — A surface defined by 14 CFR Part 77, Objects Affecting Navigable Airspace, which is longitudinally centered on the runway centerline and extends outward and upward from each end of the primary surface. An approach surface is applied to each end of each runway based on the type of approach available or planned for that runway end.

Area of Potential Effects — The geographic area or areas within which an undertaking may directly or indirectly cause alterations in the character or use of historic properties, if any such properties exist. The area of potential effects is influenced by the scale and nature of an undertaking and may be different for different kinds of effects caused by the undertaking.

Average Sound Level — The level, in decibels, of the mean square, A-weighted sound pressure during a specified period, with reference to the square of the standard reference sound pressure of 20 micropascals. Also called *equivalent sound level* and often referred to by its symbol, L_{eq} .

Aviation and Safety and Noise Abatement Act of 1979 (ASNA) — As amended (49 U.S.C. 2101 et seq.), authorizes the FAA to regulate air noise compatibility planning and fund noise compatibility programs.

Avigation Easement — A grant of a property interest in land over which a right of unobstructed flight in the airspace is established.

Based Aircraft — An aircraft permanently stationed at an airport by agreement between the aircraft owner and the airport management.

Building Codes — Codes, either local or state, that control the functional and structural aspects of buildings and/or structures. Local ordinances typically require proposed buildings to comply with zoning requirements before building permits can be issued under the building codes.

Change Order — A request by the contractor to alter the prescribed construction.

Code of Federal Regulations (CFR) Title 14, Aeronautics and Space — The contents of these five volumes represent all current regulations codified under Title 14 of the CFR and are arranged as follows: Parts 1–59, 60–139, 140–199, 200–1199, and 1200–end. The first three volumes, containing Parts 1–199, are made up of Chapter I – Federal Aviation Administration, Department of Transportation (DOT). The fourth volume, containing Parts 200–1199 is composed of Chapter II – Office of the Secretary, DOT (Aviation Proceedings) and Chapter III – Commercial Space Transportation, Federal Aviation Administration, DOT. The fifth volume, containing Part 1200–end, is made up of Chapter V – National Aeronautics and Space Administration.

CFR Part 77, Objects Affecting Navigable Airspace — Title 14 CFR Part 77 (a) establishes standards for determining obstructions in navigable airspace, (b) defines the requirements for notice to the FAA administrator of certain proposed construction or alteration, (c) provides for aeronautical studies of obstructions to air navigation to determine their effect on the safe and efficient use of airspace, (d) provides for public hearings on the hazardous effect of proposed construction or alteration on air navigation, and (e) provides for establishing antenna farm areas.

CFR Part 150, Airport Noise Compatibility Planning — Title 14 CFR Part 150 prescribes the procedures, standards, and methodology governing the development, submission, and review of airport noise exposure maps and airport noise compatibility programs, including the process for evaluating and approving or disapproving those programs. It prescribes single systems for (a) measuring noise at airports and surrounding areas, which generally provides a highly reliable relationship between projected noise exposure and surveyed reaction of people to noise, and (b) determining exposure of individuals to noise that results from the operations of an airport. This part also identifies those land uses that are normally compatible with various levels of exposure to noise by individuals. It provides technical assistance to airport operators, in conjunction with local, state, and federal authorities, to prepare and execute appropriate noise compatibility planning and implementation programs.

CFR Part 150 Study — Refers to an airport operator's noise compatibility planning study, performed in accordance with 14 CFR Part 150, which allows airport owners to voluntarily submit noise exposure maps and noise compatibility programs to the FAA for review and approval. See *Noise Compatibility Program*.

Coincidence Dip — A drop in the transmission loss of a material or assembly at a certain frequency caused by resonance effects. This resonance causes a dip in the TL curve at the resonant frequency and is perceived as an amplification of sound at the resonant frequency. Nearly all building materials have a coincidence region where multiple resonances affect the TL along a frequency region, causing the slope of the TL curve to decline over the region.

Commercial Service Airport — A public airport that has at least 2,500 passenger boardings each year and is receiving scheduled passenger aircraft service.

Community Noise Equivalent Level (CNEL) — A noise measure used in California to describe the average aircraft noise levels over a 24-hour period, typically an average day over the course of a year. CNEL is similar to DNL but with an additional evening penalty. CNEL values are typically less than 1 dB above the corresponding DNL value.

Compatible Land Use — As defined in 14 CFR Part 150, the use of land (e.g., commercial, industrial, agricultural) that is normally compatible with aircraft and airport operations, or sound-insulated land uses (e.g., sound-insulated homes, schools, nursing homes, hospitals, libraries) that would otherwise be considered incompatible with aircraft and airport operations.

Composite Transmission Loss (CTL) — The total net noise reduction from the transmission loss of all materials and systems surrounding a room.

Comprehensive Plan — Similar to a master plan, the comprehensive plan is a governmental entity's official statement of its plans and policies for long-term development. The plan includes maps, graphics, and written proposals that indicate the general location for streets, parks, schools, public buildings, airports, and other physical development of the jurisdiction.

Consultation — The process of seeking, discussing, and considering the views of other participants and, where feasible, seeking agreement with them regarding matters arising in the Section 106 process. The Secretary of Transportation's Standards and Guidelines for Federal Agency Preservation Programs pursuant to the National Historic Preservation Act provides further guidance on consultation.

Day-Night Average Sound Level (DNL) — A noise measure used to describe the average aircraft noise levels over a 24-hour period with a nighttime noise penalty, typically an average day over the course of a year. Similar to CNEL, but without the evening penalty. DNL may be determined for individual locations or expressed in noise contours. The symbol for DNL is L_{dn} .

Decibel (dB) — Sound is measured by its pressure or energy in terms of decibels. The decibel scale is logarithmic; when the scale increases by 10, the perceived sound is two times as loud.

Effect — Alteration to the characteristics of an historic property, qualifying it for inclusion in or eligibility for the National Register.

Eligible — The term *eligible for inclusion* in the National Register includes both properties formally determined as such in accordance with regulations of the Secretary of the Interior and all other properties that meet the National Register criteria.

Environmental Assessment (EA) — A concise document that assesses the environmental impacts of a proposed federal action. The EA discusses the need for and environmental impacts of the proposed action and alternative actions. An EA should provide sufficient evidence and analysis for a federal determination on whether to prepare an Environmental Impact Statement or a Finding of No Significant Impact.

Environmental Impact Statement (EIS) — A document that provides full and fair discussion of the significant environmental impacts that would occur as a result of a proposed project and that informs decision makers and the public of the reasonable alternatives that would avoid or minimize adverse impacts.

Exception — An exemption from an established acoustical retrofit standard of a program, usually granted to a single home or a few homes. Also, a waiver.

Federal Aviation Administration — The federal agency charged with regulating air commerce to promote its safety and development; with encouraging and developing civil aviation, air traffic control, and air navigation; and with promoting the development of a national system of airports.

Federal Aviation Regulations (FAR) — Rules prescribed by the FAA governing all aviation activities in the United States. They are codified in Title 14 of the CFR. They are organized into sections, called parts. Each part deals with a specific type of activity.

Federal Grant Assurance — The terms and conditions of accepting AIP grants from the FAA for carrying out the provisions of Title 49 of the USC. The terms and conditions become applicable when the airport sponsor accepts a grant offer from the FAA.

Finding of No Significant Impact (FONSI) — A document briefly explaining the reasons an action will not have a significant effect on the human environment and therefore justifies the decision to not prepare an Environmental Impact Statement. A FONSI is issued by the federal agency following the preparation of an Environmental Assessment.

General Aviation (GA) — Refers to all civil aircraft and operations that are not classified as air carrier, commuter, or regional. The types of aircraft used in general aviation activities cover a wide spectrum, from corporate multi-engine jet aircraft piloted by professional crews to amateur-built single-engine piston acrobatic planes, balloons, and dirigibles.

Heating, Ventilating, and Air Conditioning (HVAC) — The technology of indoor environmental comfort.

High-Velocity Hurricane Zone (HVHZ) — All areas with wind speeds in excess of 140 mph. Designates coastal U.S. geographic areas incorporating large areas of the Atlantic and Gulf of Mexico coastlines.

Historic Property — Any prehistoric or historic district, site, building, structure, or object included in or eligible for inclusion in the National Register of Historic Places maintained by the Secretary of the Interior.

Hourly Noise Level (HNL) — The average sound level over an hour.

Housing Codes — The codes that usually apply to both existing and future living units. The codes include minimum standards of occupancy, and usually govern spatial, ventilation, wiring, plumbing, structural, and heating requirements.

Incompatible Land Use — See *Noncompatible Land Use*.

Instrument Approach — A series of predetermined maneuvers for the orderly transfer of an aircraft under instrument flight conditions, from the beginning of the initial approach to a landing or to a point from which a landing may be made visually.

Instrument Flight Rules — Rules governing the procedure for conducting instrument flight.

Integrated Noise Model (INM) — The FAA's computer model used by the aviation community for evaluating aircraft noise impacts near airports. The INM uses a standard database of aircraft characteristics and applies them to an airport's average operational day to produce noise contours.

International Building Code (IBC) — The International Building Code is a model building code developed by the International Code Council. A model building code has no legal status until it is adopted or adapted by government regulation. The IBC was developed to consolidate existing building codes into one uniform code that could be used nationally and internationally to construct buildings.

International Organization for Standardization (ISO), (French: *Organisation Internationale de Normalisation*) — An international standard-setting body composed of representatives from various national standards organizations.

Itinerant Operation — Any aircraft arrival and/or departure other than a local operation.

Land Use Compatibility — The coexistence of land uses surrounding the airport with airport-related activities.

Land Use Controls — Measures established by state or local government that are designed to carry out land use planning. The controls include zoning, subdivision regulations, planned acquisition, easements, covenants, and conditions in building codes and capital improvement programs, such as establishment of sewer, water, utilities, and their service facilities.

Land Use Management Measures — Techniques that consist of both remedial and preventive measures for managing land use. Remedial, or corrective, measures typically include sound insulation or land acquisition. Preventive measures typically involve land use controls that amend or update local zoning ordinances, comprehensive plans, subdivision regulations, and building codes.

Local Operation — Any operation performed by an aircraft that (a) operates in the local traffic pattern or within sight of the tower or airport; (b) is known to be departing for, or arriving from, flight in local practice areas located within a 20-mile radius of the control tower or airport; or (c) executes a simulated instrument approach or low pass at the airport.

Memorandum of Agreement — The document that records the terms and conditions agreed upon to resolve the adverse effects of an undertaking upon historic properties.

Mitigation — The avoidance, minimization, reduction, elimination, or compensation for adverse environmental effects of a proposed action.

Mitigation Measure — An action taken to alleviate an adverse impact.

National Environmental Policy Act of 1969 (NEPA) — The original legislation establishing the environmental review process.

National Plan of Integrated Airport Systems (NPIAS) — An inventory of U.S. aviation infrastructure assets. Developed and maintained by the FAA, its purposes are to (a) identify all the airports in the United States that are considered significant components of the national aviation infrastructure network; (b) qualify the current state of development, technology, and repair at each of these airports; and (c) estimate the funding needed to bring each airport up to current standards of design, technology, and capacity. Airports in the NPIAS are eligible for federal grants from the AIP.

National Register — The National Register of Historic Places maintained by the Secretary of the Interior.

National Register Criteria — The criteria established by the Secretary of the Interior for use in evaluating the eligibility of properties for the National Register (36 CFR part 60).

National Voluntary Laboratory Accreditation Program (NVLAP) — A National Institute of Standards and Technology program that provides an unbiased third-party test and evaluation program to accredit laboratories in their respective fields to the ISO 17025 standard.

Navigation Aids — Any facility used by an aircraft for guiding or controlling flight in the air or for the landing or takeoff of an aircraft.

Noise Abatement Procedures — Changes in runway usage, flight approach and departure routes and procedures, and vehicle movement such as ground maneuvers or other air traffic procedures, that shift aviation impacts away from noise sensitive areas.

Noise Compatibility Program (NCP) — The NCP consists of an optimum combination of preferred noise abatement and land use management measures and a plan for the implementation of these measures. For planning purposes, the implementation plan also includes the estimated cost for each of the recommended measures to the airport sponsor, the FAA, airport users, and the local units of government.

Noise Exposure Contours — Lines drawn about a noise source indicating constant energy levels of noise exposure. DNL is the measure used to describe community exposure to noise.

Noise Exposure Map (NEM) — The NEM is a scaled map of the airport, its noise contours, and surrounding land uses. The NEM depicts the levels of noise exposure around the airport, both for the existing conditions and forecasts for the 5-year planning period. The area of noise exposure is designated using the DNL noise metric.

Noise Level Reduction (NLR) — The reduction in noise, measured in decibels, achieved through incorporation of noise attenuation (between outdoor and indoor levels) in the design and construction of a structure. NLR includes the net noise reduction arising from the transmission loss of all building materials and systems as well as the room acoustics effects of the receiving room.

Noise-Sensitive Area — Areas where aircraft noise may interfere with existing or planned use of the land. Whether noise interferes with a particular use depends on the level of noise exposure and the types of activities that are involved. Residential neighborhoods; educational, health, and religious structures and sites; and outdoor recreational, cultural, and historic sites may be noise-sensitive areas.

Noncompatible Land Use — The use of land, as defined in Appendix A, Table 1 of 14 CFR Part 150, which is normally noncompatible with the aircraft and airport operations (such as homes, schools, nursing homes, hospitals, and libraries).

Off-Airport Property — Property that is beyond the boundary of land owned by the airport sponsor.

On-Airport Property — Property that is within the boundary of land owned by the airport sponsor.

Outdoor–Indoor Transmission Class (OITC) — A standard used for indicating the rate of transmission of sound between outdoor and indoor spaces of a structure. It is based on ASTM E-1332, Standard Classification for the Determination of Outdoor–Indoor Transmission Class.

Overlay Zone — A mapped zone that imposes a set of requirements in addition to those of the underlying zoning district.

Packaged Terminal Air Conditioning Unit (PTAC) — A type of self-contained heating and air conditioning system commonly found in hotels and apartment buildings. Many are designed to go through a wall, having vents and heat sinks both inside and outside.

Passenger Facility Charge (PFC) Program — The PFC Program, first authorized by the Aviation Safety and Capacity Expansion Act of 1990 and now codified under Section 40117 of Title 49 USC, provides a source of additional capital to improve, expand, and repair the nation's airport infrastructure. The legislation allows public agencies controlling commercial service airports to charge enplaning passengers using the airport a facility charge. The FAA must approve any facility charges imposed on enplaning passengers.

Performance Standards — Minimum acceptable levels of performance, imposed by zoning, that must be met by each land use.

Polyvinyl Butyral (PVB) — An interlayer material used in laminate glass.

Primary Runway — The runway used for the majority of airport operations. Large, high-activity airports may operate two or more parallel primary runways.

Programmatic Agreement (PA) — A document that records the terms and conditions agreed upon to resolve the potential adverse effects of a federal agency program, complex undertaking, or other situations in accordance with 36 CFR 800.14(b).

Public Use Airport — A publicly or privately owned airport that offers the use of its facilities to the public without prior notice or special invitation or clearance.

Record of Approval (ROA) — A concise public record of the decision made by the FAA with respect to an airport's proposed NCP, prepared in accordance with 14 CFR Part 150.

Record of Decision (ROD) — A concise public record of the decision made by the FAA with respect to an EIS, prepared in accordance with Title 40 CFR, Chapter V, for a major federal action that significantly affects the quality of the human environment. The ROD discusses all options considered by the FAA, commits to mitigation and other conditions established in the EIS or during its review, and includes a monitoring and enforcement program to ensure that the prescribed mitigation is carried out.

Reliever Airport — An airport that meets certain FAA criteria and relieves the aeronautical demand on a busier air carrier airport.

Request for Information (RFI) — A request by the contractor for clarification of a design or specification.

Runway Protection Zone (RPZ) — A trapezoidal-shaped area centered about the extended runway centerline that is used to enhance the safety of aircraft operations. It begins 200 feet beyond the end of the runway or area usable for takeoff or landing. The RPZ dimensions are functions of the design aircraft, type of operation, and visibility minimums.

Single Event Noise Equivalent Level (SENEL) — The designation in California for SEL.

Sound Attenuation — Acoustical phenomenon whereby a reduction of sound energy is experienced between the noise source and the receiver. This energy loss can be attributed to atmospheric conditions, terrain, vegetation, constructed features (e.g., sound insulation), and natural features.

Sound Exposure Level (SEL) — A measure of the physical energy of the noise event that takes into account both sound level and duration. By definition, SEL values are referenced to a duration of 1 second. SEL is higher than the average and maximum noise levels as long as the event is longer than 1 second. Sound exposure level is expressed in decibels.

Sound Insulation Program (SIP) — An FAA-funded project and the subject of these guidelines.

Sound Reduction Index — A metric to measure the level of sound insulation provided by a structure such as a wall, window, door, or ventilator. It is defined in the series of international standards ISO 140 (Parts 1-14) or the regional or national variants on these standards.

Sound Transmission Class (STC) — An integer rating of how well a building partition attenuates airborne sound. In the United States, it is widely used to rate interior partitions, ceilings/floors, doors, windows, and exterior wall configurations (see ASTM E413 and ASTM E90).

Sound Transmission Loss — A measure of the noise reduction of a building material or element in units of dB.

Special Exceptions — Land uses that are not specifically permitted as a matter of right but can be permitted in accordance with performance standards and other local criteria. Also referred to as *conditional uses*.

Stage 2 Aircraft — Aircraft that meet the noise levels prescribed by 14 CFR Part 36, which are less stringent than noise levels established for the quieter designation of Stage 3 aircraft. The Airport Noise and Capacity Act required the phaseout of all Stage 2 aircraft by December 31, 1999, with case-by-case exceptions through the year 2003.

Stage 3 Aircraft — Aircraft that meet the most stringent noise levels set forth in 14 CFR Part 36.

State Historic Preservation Officer (SHPO) — The official appointed or designated, pursuant to section 101(b)(1) of National Historic Preservation Act of 1966, to administer the state historic preservation program; or a representative designated to act for the state historic preservation officer.

Tribal Historic Preservation Officer (THPO) — The tribal official appointed by the tribe's chief governing authority or designated by a tribal ordinance or preservation program who has assumed the responsibilities of the SHPO for purposes of Section 106 compliance on tribal lands in accordance with section 101(d)(2) of the National Historic Preservation Act of 1966.

Turbofan Aircraft — Aircraft operated by jet engines incorporating a turbine-driven air compressor to intake and compress the air for the combustion of fuel, the gases of combustion (or the heated air) being used both to rotate the turbine and to create a thrust-producing jet.

Turbojet Aircraft — Aircraft operated by jet engines incorporating a turbine-driven air compressor to intake and compress the air for the combustion of fuel, the gases of combustion (or the heated air) being used solely to create a thrust-producing jet.

Turboprop Aircraft — Aircraft in which the main propulsive force is supplied by a gas-turbine-driven conventional propeller. Additional propulsive force may be supplied from the discharged turbine exhaust gas.

Undertaking — A project, activity, or program funded in whole or in part under the direct or indirect jurisdiction of a federal agency, including those carried out by or on behalf of a federal agency, those carried out with federal financial assistance, and those requiring a federal permit, license, or approval.

Unites States Code (USC) Title 49 — A code that concerns the role of transportation in the United States. Subtitle VII addresses aviation programs. Part B of Subtitle VII addresses airport development and noise.

Variance — An authorization for the construction or maintenance of a building or structure or for the establishment or maintenance of a use of land that is prohibited by a zoning ordinance. A lawful exception from specific zoning ordinance standards and regulations predicated on the practical difficulties or unnecessary hardships on the petitioner being required to comply with those regulations and standards from which an exemption or exception is sought.

Visual Approach — An approach to an airport conducted with visual reference to the terrain.

Visual Flight Rules — Rules that govern flight procedures in good weather, with conditions usually being at least a 1,000-ft ceiling and 3 miles of visibility.

Waiver — An exemption from an established acoustical retrofit standard of a program, usually granted to a single home or a few homes. Also, an exception.

Wood and Door Manufacturers Association (WDMA) — Provides industry standards in the residential and commercial window, door, and skylight industry.

Yearly Day–Night Average Sound Level — The 365-day average, in decibels, day–night average sound level.

Zoning — The partitioning of land parcels in a community by ordinance into zones and the establishment of regulations in the ordinance to govern the land use and the location, height, use, and land coverage of buildings within each zone. The zoning ordinance usually consists of text and a zoning map.

Zoning Ordinance — Primarily a legal document that allows a local government effective and legal regulation of uses of property while protecting and promoting the public interest.



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Also see Appendix A for a List of Key FAA Documents

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Abbreviations and acronyms used without definitions in TRB publications:

A4A	Airlines for America
AAAE	American Association of Airport Executives
AASHO	American Association of State Highway Officials
AASHTO	American Association of State Highway and Transportation Officials
ACI-NA	Airports Council International-North America
ACRP	Airport Cooperative Research Program
ADA	Americans with Disabilities Act
APTA	American Public Transportation Association
ASCE	American Society of Civil Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
ATA	American Trucking Associations
CTAA	Community Transportation Association of America
CTBSSP	Commercial Truck and Bus Safety Synthesis Program
DHS	Department of Homeland Security
DOE	Department of Energy
EPA	Environmental Protection Agency
FAA	Federal Aviation Administration
FHWA	Federal Highway Administration
FMCSA	Federal Motor Carrier Safety Administration
FRA	Federal Railroad Administration
FTA	Federal Transit Administration
HMCRP	Hazardous Materials Cooperative Research Program
IEEE	Institute of Electrical and Electronics Engineers
ISTEA	Intermodal Surface Transportation Efficiency Act of 1991
ITE	Institute of Transportation Engineers
MAP-21	Moving Ahead for Progress in the 21st Century Act (2012)
NASA	National Aeronautics and Space Administration
NASAO	National Association of State Aviation Officials
NCFRP	National Cooperative Freight Research Program
NCHRP	National Cooperative Highway Research Program
NHTSA	National Highway Traffic Safety Administration
NTSB	National Transportation Safety Board
PHMSA	Pipeline and Hazardous Materials Safety Administration
RITA	Research and Innovative Technology Administration
SAE	Society of Automotive Engineers
SAFETEA-LU	Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (2005)
TCRP	Transit Cooperative Research Program
TEA-21	Transportation Equity Act for the 21st Century (1998)
TRB	Transportation Research Board
TSA	Transportation Security Administration
U.S.DOT	United States Department of Transportation

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